

INTERNATIONAL STANDARD

NORME INTERNATIONALE



High-voltage switchgear and controlgear –
Part 4: Handling procedures for sulphur hexafluoride (SF₆) and its mixtures
(standards.iteh.ai)

Appareillage à haute tension –
Partie 4: Utilisation et manipulation de l'hexafluorure de soufre (SF₆) et des
mélanges contenant du SF₆



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2013 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 la CEI ou du Comité national de la CEI du pays du demandeur.

Si vous avez des questions sur le copyright de la CEI ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de la CEI de votre pays de résidence.

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

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
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 corrigenda or an amendment might have been published.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you to find IEC publications by a variety of criteria (reference number, text, technical committee,...).

It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available on-line and also once a month by email.

Electropedia - www.electropedia.org

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

Customer Service Centre - webstore.iec.ch/csc

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

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) 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 CEI

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

Liens utiles:

Recherche de publications CEI - www.iec.ch/searchpub

La recherche avancée vous permet de trouver des publications CEI 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.

Just Published CEI - webstore.iec.ch/justpublished

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

Electropedia - www.electropedia.org

Le premier dictionnaire en ligne au monde de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

Service Clients - webstore.iec.ch/csc

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

INTERNATIONAL STANDARD

NORME INTERNATIONALE



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

Appareillage à haute tension –
Partie 4: Utilisation et manipulation de l'hexafluorure de soufre (SF₆) et des
mélanges contenant du SF₆

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.130.10; 29.130.99

ISBN 978-2-8322-1042-0

**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.**

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 General.....	8
1.1 Scope.....	8
1.2 Normative references.....	8
2 Terms and definitions.....	9
3 SF ₆ handling during installation and commissioning.....	11
3.1 General.....	11
3.2 Evacuation, filling and checking the SF ₆ quality after filling.....	11
3.3 Topping-up of SF ₆ pre-filled compartments to the rated filling pressure/density.....	13
3.4 Filling sealed pressure systems.....	15
4 SF ₆ handling during normal service life.....	15
4.1 Re-filling of SF ₆ to the rated filling pressure/density.....	15
4.2 Checking the SF ₆ quality.....	16
4.2.1 General.....	16
4.2.2 Measurement of the SF ₆ quality with portable equipment.....	16
4.2.3 Sampling and shipment of SF ₆ for off-site analysis.....	17
5 SF ₆ recovery and reclaim during maintenance.....	18
5.1 General.....	18
5.2 SF ₆ recovery and reclaim from any compartment of controlled or closed pressure systems containing non-arced or normally arcad SF ₆	18
5.3 Recovery and reclaim from any compartment of controlled or closed pressure systems containing heavily arcad SF ₆	20
6 Dismantling of SF ₆ electric power equipment at the end-of-life.....	22
6.1 General.....	22
6.2 End-of-life of controlled or closed pressure systems.....	23
6.3 End-of-life of sealed pressure systems.....	23
6.4 SF ₆ recovery and reclaim at the end-of-life of sealed pressure systems.....	24
6.5 Dismantling of electric power equipment at the end-of-life.....	26
6.6 By-products at the end-of-life.....	27
Annex A (informative) Storage and transportation of SF ₆	29
Annex B (informative) Safety and first aid.....	33
Annex C (informative) Training and certification.....	39
Annex D (informative) Description of SF ₆ Handling Equipment.....	43
Annex E (informative) Sulphur hexafluoride.....	51
Annex F (informative) Environmental effects of SF ₆	55
Annex G (informative) SF ₆ by-products.....	58
Annex H (informative) Procedure for evaluating the potential effects on health of SF ₆ by-products.....	61
Annex I (informative) Cryogenic reclaim of SF ₆	67
Annex J (normative) Handling of SF ₆ mixtures.....	71
Bibliography.....	76
Figure 1 – Evacuation, filling and checking the SF ₆ quality after filling.....	12

Figure 2 – Topping-up of SF ₆ pre-filled compartments to the rated filling pressure/density	14
Figure 3 – SF ₆ re-filling to the rated filling pressure/density.....	15
Figure 4 – Checking the SF ₆ quality on-site.....	17
Figure 5 – SF ₆ sampling and shipment	18
Figure 6 – Example of recovery and reclaim from any compartment of controlled or closed pressure systems containing non-arced or normally arc'd SF ₆	19
Figure 7 – Example of recovery and reclaim from any compartment of controlled or closed pressure systems containing heavily arc'd SF ₆	21
Figure 8 – End-of-life of controlled or closed pressure systems.....	23
Figure 9 – End-of-life of sealed pressure systems.....	24
Figure 10 – SF ₆ recovery and reclaim at the end-of-life of sealed pressure systems.....	25
Figure 11 – Dismantling of electric power equipment	27
Figure D.1 – General purpose reclaimer	43
Figure D.2 – Gas mixing device	49
Figure E.1 – Pressure/temperature/density characteristics for SF ₆ [16]	52
Figure H.1 – Procedure for the evaluation of the potential effects on health due to arcing	65
Figure H.2 – Procedure for the evaluation of the potential effects on health due to low energy discharges	66
Figure I.1 – Saturated vapour pressure of various gases as a function of temperature	68
Figure I.2 – Typical cryogenic reclaimer for SF ₆ recovery on site.....	69
Figure I.3 – Typical cryogenic reclaimer for removing contaminants.....	70
Figure J.1 – Vapour pressure of SF ₆	74
Figure J.2 – Maximum SF ₆ storage density to avoid SF ₆ liquefaction	75
Table 1 – Evacuation, filling and checking the SF ₆ quality after filling.....	13
Table 2 – Topping-up of SF ₆ pre-filled compartments to the rated filling pressure/density.	14
Table 3 – SF ₆ re-filling to the rated filling pressure/density.....	16
Table 4 – Checking the SF ₆ quality on-site	17
Table 5 – SF ₆ sampling and shipment	18
Table 6 – Example of recovery and reclaim from any compartment of controlled or closed pressure systems containing non-arc'd or normally arc'd SF ₆	20
Table 7 – Example of recovery and reclaim from any compartment of controlled or closed pressure systems containing heavily arc'd SF ₆	22
Table 8 – SF ₆ recovery at the end-of-life of sealed pressure systems.....	26
Table 9 – Expected SF ₆ characteristics and quantity of by-products	28
Table A.1 – Methods for storage of SF ₆	29
Table A.2 – Container types and labelling required for storage and transportation of SF ₆	30
Table A.3 – International regulations for shipment of SF ₆	31
Table B.1 – Measures when working with SF ₆ electric power equipment.....	33
Table B.2 – Safety measures when opening or accessing gas compartments.....	34
Table B.3 – Neutralising solutions.....	35
Table B.4 – Additional safety measures	37

Table D.1 – Typical filter types used during SF ₆ reclaim	44
Table D.2 – Gas measuring devices	47
Table E.1 – Main chemical characteristics of SF ₆ [16]	51
Table E.2 – Main physical characteristics of SF ₆ [16]	53
Table E.3 – Main electrical characteristics of SF ₆ [16]	53
Table H.1 – OELs for SO ₂ , HF, and S ₂ F ₁₀	63
Table H.2 – SOF ₂ production rate	63

iTeh STANDARD PREVIEW
(standards.iteh.ai)

[IEC 62271-4:2013](https://standards.iteh.ai/catalog/standards/sist/a49d12dd-1f25-43f6-9c9c-1d52362d4397/iec-62271-4-2013)

<https://standards.iteh.ai/catalog/standards/sist/a49d12dd-1f25-43f6-9c9c-1d52362d4397/iec-62271-4-2013>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

**Part 4: Handling procedures for sulphur hexafluoride (SF₆)
and its mixtures**

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 committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization 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.
- 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 62271-4 has been prepared by subcommittee 17A: High-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

This first edition cancels and replaces the first edition of IEC/TR 62271-303 published in 2008.

This first edition constitutes a technical revision. This edition includes the following significant technical changes with respect to the previous edition:

- a) the description of the potential effects on health of SF₆ by-products (former Annex D of IEC/TR 62271-303:2008) has been replaced by the calculation methods for evaluating of the potential effects on health of SF₆ by-products (see Annex H);
- b) information about cryogenic reclaim of SF₆ have been added (see Annex I);
- c) handling procedures for the most popular SF₆ mixtures have been added (see Annex J).

The text of this standard is based on the following documents:

FDIS	Report on voting
17A/1044/FDIS	17A/1051/RVD

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

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

A list of all parts in the IEC 62271, published under the general title *High-voltage switchgear and controlgear*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

iTeh STANDARD PREVIEW

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.

<https://standards.iteh.ai/catalog/standards/sist/a49d12dd-1f25-43f6-9c9c-1d52362d4397/iec-62271-4-2013>

INTRODUCTION

As agreed with TC 10, annexes A, E, F, G, H and I will be removed from this document as soon as the revised editions of IEC 60376 and IEC 60480 have been published.

iTeh STANDARD PREVIEW **(standards.iteh.ai)**

[IEC 62271-4:2013](https://standards.iteh.ai/catalog/standards/sist/a49d12dd-1f25-43f6-9c9c-1d52362d4397/iec-62271-4-2013)

<https://standards.iteh.ai/catalog/standards/sist/a49d12dd-1f25-43f6-9c9c-1d52362d4397/iec-62271-4-2013>

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 4: Handling procedures for sulphur hexafluoride (SF₆) and its mixtures

1 General

1.1 Scope

This part of IEC 62271 applies to the procedures for handling of SF₆ during installation, commissioning, normal and abnormal operations, disposal at the end-of-life of high-voltage switchgear and controlgear.

These procedures are regarded as minimum requirements to ensure the safety of personnel working with SF₆ (see Annex B) and to minimize the SF₆ emission to the environment.

This standard generally applies also to gas mixtures containing SF₆. The particularities for their handling are covered in Annex J.

NOTE 1 Throughout this standard, use of the term High-Voltage (refer to IEC 60050-601:1985, 601-01-27) means a rated voltage above 1 000 V. However the term Medium Voltage (refer to IEC 60050-601: 1985, 601-01-28) is commonly used for distribution systems with voltages above 1 kV and generally applied up to and including 52 kV.

NOTE 2 Throughout this standard, the term “electric power equipment” stands for “high-voltage and medium-voltage switchgear and controlgear”.

NOTE 3 Throughout this standard, the term “pressure” stands for “absolute pressure”.
<https://standards.iteh.ai/catalog/standards/sist/a49d12dd-1f25-43f6-9c9c-1d52362d4397/iec-62271-4-2013>

1.2 Normative references

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

IEC 60050-441, *International Electrotechnical Vocabulary – Chapter 441: Switchgear, controlgear and fuses*

IEC 60050-601, *International Electrotechnical Vocabulary – Chapter 601: Generation, transmission and distribution of electricity – General*

IEC 60376, *Specification of technical grade sulphur hexafluoride (SF₆) for use in electrical equipment*

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

IEC 62271-1, *High-voltage switchgear and controlgear – Part 1: Common specifications*

EN 1089-3, *Transportable gas cylinders. Gas cylinder identification (excluding LPG). Colour coding*

2 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-441 and IEC 60050-601, as well as the following apply.

2.1

abnormal release of SF₆

release from equipment in service due to a failure in the pressure system or mistake in the handling process

Note 1 to entry: An abnormal SF₆ leak is usually an unwanted and continuous emission of gas at a higher rate than the equipment designed leak rate. As soon as an abnormal SF₆ leak is detected, appropriate measures to locate and eliminate it should be arranged.

2.2

handling of SF₆

any process which might involve transfer of SF₆

2.3

evacuation

transfer of a gas different from SF₆ (e.g. air or N₂) which can be released into the atmosphere. The operation is performed utilising a vacuum pump

2.4

recovery of SF₆

transfer of SF₆ from the gas compartment into a reclaimer or storage container

Note 1 to entry: The operation is normally performed utilising a recovery compressor.

2.5

topping-up with SF₆

filling a pre-filled compartment with SF₆ to the rated filling pressure

Note 1 to entry: Pre-filled compartments are closed pressure systems filled in the factory prior to shipment. They contain SF₆ at a typical pressure between 0,12 MPa to 0,15 MPa allowing for a faster and easier commissioning on-site.

2.6

re-filling with SF₆

filling a compartment with SF₆ to the rated filling pressure to assure continuity of service

2.7

reclaim of SF₆

a series of SF₆ handling procedures including recovery and minimum SF₆ refining process such as filtering dust, by-products, moisture, oil, etc.

Note 1 to entry: A standard reclaimer is described in Annex D; while a cryogenic reclaimer is described in Annex I.

Note 2 to entry: Sometimes the words "reclaiming" or "reclamation" may be used with the same meaning as "reclaim".

2.8

gas-insulated metal-enclosed switchgear

metal-enclosed switchgear in which the insulation is obtained, at least partly, by an insulating gas other than air at atmospheric pressure

Note 1 to entry: This term generally applies to high-voltage switchgear and controlgear.

[SOURCE: IEC 60050-441: 1984, 441-12-05]

2.9**gas-filled compartment**

compartment of switchgear and controlgear in which the gas pressure is maintained by one of the following systems:

- controlled pressure system;
- closed pressure system;
- sealed pressure system

Note 1 to entry: Several gas-filled compartments may be permanently interconnected to form a common gas-system (gas-tight assembly).

Note 2 to entry: The definition is the same as in IEC 62271-1.

2.10**controlled pressure system for gas**

volume which is automatically replenished from an external compressed gas supply or internal gas source

Note 1 to entry: Examples of controlled pressure systems are air-blast circuit-breakers or pneumatic operating mechanisms.

Note 2 to entry: A volume may consist of several permanently connected gas-filled compartments.

Note 3 to entry: The definition is the same as in IEC 62271-1.

2.11**closed pressure system for gas**

volume which is replenished only periodically by manual connection to an external gas source

Note 1 to entry: Example of closed pressure systems are SF₆ single pressure circuit-breakers.

Note 2 to entry: The definition is the same as in IEC 62271-1.

2.12**sealed pressure system**

volume for which no further gas or vacuum processing is required during its expected operating life

Note 1 to entry: Examples of sealed pressure systems are tubes of vacuum circuit-breakers or some SF₆ circuit-breakers.

Note 2 to entry: Sealed pressure systems are completely assembled and tested in the factory.

Note 3 to entry: The definition is the same as in IEC 62271-1.

2.13**technical grade SF₆**

SF₆ gas having a very low level of impurities in accordance with IEC 60376

2.14**used SF₆**

gas removed from an item of electrical equipment, initially filled with SF₆ according to IEC 60376 or IEC 60480

Note 1 to entry: If after filling, the gas is removed for any purpose during the life of the equipment, e.g. repair, service, maintenance, the gas will be transferred and is considered as used gas.

Note 2 to entry: Annex G provides information regarding the by-products of used SF₆, which occur in both gaseous and solid form.

2.15**used SF₆ suitable for reuse on site**

used SF₆ having a maximum impurity level in accordance with IEC 60480

Note 1 to entry: If necessary, service units with appropriate filters and adsorber materials should be used.

2.16

used SF₆ suitable for reuse at the gas manufacturer

used SF₆ exceeding the maximum acceptable impurity level stated in IEC 60480, suitable for reuse by the gas manufacturer

Note 1 to entry: If necessary to meet the specification, service units with appropriate filters and adsorber materials should be used.

2.17

used SF₆ not suitable for reuse

used SF₆ not falling under the category defined under 2.15 or 2.16

Note 1 to entry: Used SF₆ not suitable for reuse is disposed according to local or international regulations on waste management.

2.18

non-arced SF₆

used SF₆ having less than approximately 1 ml/l (0,1 % by volume) of gaseous by-products

Note 1 to entry: Non-arced SF₆ is typically expected to be in any compartment after filling and prior to energising or after insulation testing or in insulation compartments which never experienced arcing.

2.19

normally arcad SF₆

used SF₆ having between approximately 1 ml/l (0,1 % by volume) and approximately 10 ml/l (1 % by volume) of gaseous by-products.

Note 1 to entry: Normally arcad SF₆ is typically expected to be in circuit breakers or switches after normal (load or fault) operations.

Note 2 to entry: A small amount of solid by-products, mainly metal fluorides and tungsten oxifluorides, may be present as well.

2.20

heavily arcad SF₆

used SF₆ having more than approximately 10 ml/l (1 % by volume.) of gaseous by-products

Note 1 to entry: Heavily arcad SF₆ is typically expected to be in any gas compartments after internal arc fault or circuit breakers or switches after interruption failure or circuit breakers after successful interruptions of several short circuits at high amplitude in relation with its ratings.

Note 2 to entry: A large amount of solid by-products, mainly metal fluorides and tungsten oxifluorides, is expected as well.

2.21

SF₆ mixture

gas mixture formed by SF₆ and a complementary gas, typically N₂ or CF₄

3 SF₆ handling during installation and commissioning

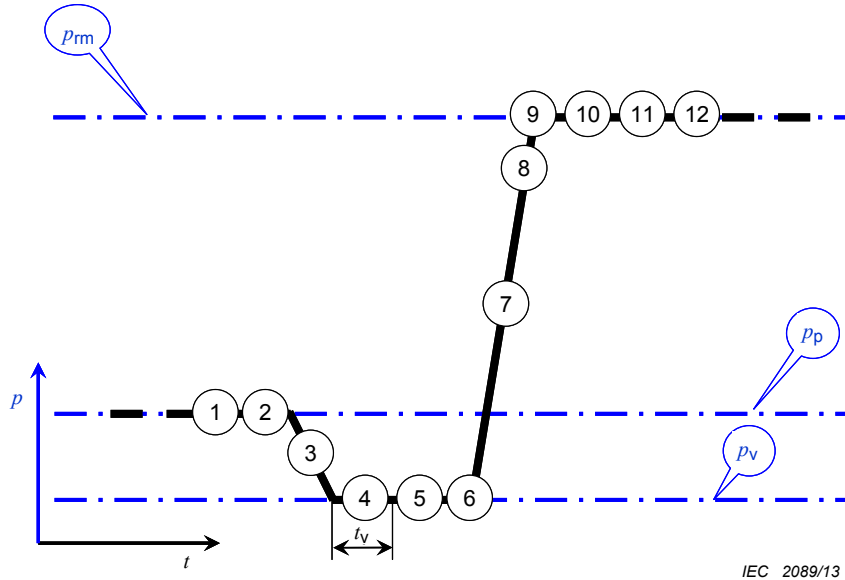
3.1 General

This clause provides guidance for working with technical grade SF₆, according to IEC 60376 or used SF₆ suitable for reuse on site, according to IEC 60480 i.e. when a gas compartment is filled, after the switchgear and controlgear has been installed on site.

3.2 Evacuation, filling and checking the SF₆ quality after filling

This subclause applies to switchgear compartments of pressure systems that currently contain a gas different from SF₆ (typically air or N₂) at ambient pressure or slight overpressure (typically 0,1 MPa to 0,15 MPa).

The following detailed sequence of operations for air/N₂ evacuation and SF₆ filling in each compartment shall be performed according to Figure 1 and Table 1, except as otherwise specified in the handling procedure detailed by the Original Equipment Manufacturer in the Operating Instruction Manual.



IEC 2089/13

1	Prepare SF ₆ handling equipment	9	Pressure/density sensor inspection
2	Adsorber installation	10	Tightness inspection
3	Evacuation	11	SF ₆ quality checking
4	Vacuum stabilisation phase	12	Documentation
5	Vacuum holding phase (optional step)	p_{rm}	SF ₆ rated filling pressure
6	Documentation	p_p	Initial pressure in the gas compartment
7	Filling with SF ₆	p_v	Evacuation pressure < 2 kPa
8	Documentation	t_v	Vacuum stabilisation time ≥ 30 min

Figure 1 – Evacuation, filling and checking the SF₆ quality after filling

Table 1 – Evacuation, filling and checking the SF₆ quality after filling

Step		Procedure
1	Prepare SF ₆ handling equipment	Check that the SF ₆ handling equipment is working properly and the gas connections are clean and dry to avoid contamination. Check the validity of the calibration of instruments subject to calibration.
2	Adsorber installation	Quickly insert the adsorber materials in the compartment. Start evacuation immediately afterwards.
3	Evacuation	Connect the vacuum pump and leave it running to reach 2 kPa.
4	Vacuum stabilisation phase	Leave the vacuum pump running for at least 30 min and then disconnect the vacuum pump by closing the valve. Read the pressure gauge. ^a
5	Vacuum holding phase (optional step)	The pressure in the compartment should remain lower than 2 kPa for the time which may be required by the Original Equipment Manufacturer in the Operating Instruction Manual].
6	Documentation	Record at least the manufacturer, equipment type reference, serial number and compartment reference to identify the gas compartment, the evacuation pressure (i.e. the residual air content), ambient temperature and date for further reference.
7	Filling with SF ₆	Connect the SF ₆ container and fill the compartment until the SF ₆ rated filling pressure is reached. Use a safety valve, a regulator to allow a good control of the filling process and a calibrated gauge to avoid overfilling. ^{b c}
8	Documentation	Record at least the manufacturer and serial number to identify the gas compartment, the final filling pressure, ambient temperature and date for further reference.
9	Pressure/density sensor inspection	Check the functionality of the pressure/density sensor. The operation can be performed during the filling operation and shall not be considered as a calibration.
10	Tightness inspection	Check the tightness of at least all permanent connections made on site as requested by the Original Equipment Manufacturer in the Operating Instruction Manual.
11	SF ₆ quality checking	Wait for the time specified by the Original Equipment Manufacturer in the Operating Instruction Manual before measuring the moisture content and the SF ₆ percentage. ^d
12	Documentation	Record at least the manufacturer and serial number to identify the gas compartment, the functionality of the pressure/density sensor, the moisture content, the SF ₆ content, ambient temperature and date for further reference.
<p>^a The vacuum duration can be prolonged in order to better remove moisture when for example the ambient temperature is freezing, except as otherwise specified by the Original Equipment Manufacturer in the Operating Instruction Manual.</p> <p>^b SF₆ to be introduced into the gas compartment may be either technical grade SF₆ or used SF₆ suitable for reuse on site.</p> <p>^c No SF₆ check is required if the gas comes from the supplier in sealed containers, or if the gas is stored in sealed containers with an appropriate label or certificate to guarantee the gas is suitable for reuse. In all other cases, the SF₆ quality may be checked prior to the filling operation (see 4.2).</p> <p>^d If the gas compartment has a small volume, re-filling after SF₆ quality checking may be required.</p>		

3.3 Topping-up of SF₆ pre-filled compartments to the rated filling pressure/density

This subclause applies to compartments of pressure systems pre-filled in the factory prior to shipment. They contain SF₆ at above atmospheric pressure (typically 0,12 MPa to 0,15 MPa), allowing for a faster and easier commissioning on-site.

The following detailed sequence of operations for SF₆ topping-up in each pre-filled compartment shall be performed according to Figure 2 and Table 2, except as otherwise specified in the handling procedure detailed by the Original Equipment Manufacturer in the Operating Instruction Manual.