

STN	Vysokonapäťové spínacie a riadiace zariadenia Časť 4: Postupy manipulácie s plynmi na izoláciu a/alebo spínanie	STN EN IEC 62271-4 35 4220
------------	--	--

High-voltage switchgear and controlgear - Part 4: Handling procedures for gases for insulation and/or switching

Táto norma obsahuje anglickú verziu európskej normy.
This standard includes the English version of the European Standard.

Táto norma bola oznámená vo Vestníku ÚNMS SR č. 11/22

Obsahuje: EN IEC 62271-4:2022, IEC 62271-4:2022

Oznámením tejto normy sa od 26.08.2025 ruší
STN EN 62271-4 (35 4220) z apríla 2014

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN IEC 62271-4

September 2022

ICS 29.130.10; 29.130.99

Supersedes EN 62271-4:2013

English Version

**High-voltage switchgear and controlgear - Part 4: Handling
procedures for gases for insulation and/or switching
(IEC 62271-4:2022)**

Appareillage à haute tension - Partie 4: Procédures de
manipulation des gaz pour l'isolation et/ou la commutation
(IEC 62271-4:2022)

Hochspannungs-Schaltgeräte und -Schaltanlagen - Teil 4:
Handhabungsmethoden für Gase zur Isolation und/oder
Unterbrechung
(IEC 62271-4:2022)

This European Standard was approved by CENELEC on 2022-08-26. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.



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

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

EN IEC 62271-4:2022 (E)**European foreword**

The text of document 17/1124/FDIS, future edition 2 of IEC 62271-4, prepared by IEC/TC 17 "High-voltage switchgear and controlgear" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62271-4:2022.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2023-05-26
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2025-08-26

This document supersedes EN 62271-4:2013 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 62271-4:2022 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC/IEEE 82079-1:2019 NOTE Harmonized as EN IEC/IEEE 82079-1:2020 (not modified)

IEC 62474:2018 NOTE Harmonized as EN IEC 62474:2019 (not modified)

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-212	2010	International Electrotechnical Vocabulary - Part 212: Electrical insulating solids, liquids and gases	-	-
+ AMD1	2015			
+ AMD2	2015		-	-
+ AMD3	2020		-	-
IEC 60050-426	2020	International Electrotechnical Vocabulary (IEV) - Part 426: Explosive atmospheres	-	-
IEC 60050-441	1984	International Electrotechnical Vocabulary. Switchgear, controlgear and fuses	-	-
+ AMD1	2000		-	-
IEC 60335-2-69	2021	Household and similar electrical appliances - Safety - Part 2-69: Particular requirements for wet and dry vacuum cleaners, including power brush, for commercial use	-	-
IEC 60376	2018	Specification of technical grade sulphur hexafluoride (SF ₆) and complementary gases to be used in its mixtures for use in electrical equipment	EN IEC 60376	2018
IEC 60480	2019	Specifications for the re-use of sulphur hexafluoride (SF ₆) and its mixtures in electrical equipment	EN IEC 60480	2019
IEC 62271-1	2017	High-voltage switchgear and controlgear - Part 1: Common specifications for alternating current switchgear and controlgear	EN 62271-1	2017
+ AMD1	2021		+ A1	2021
ISO 8573-1	2010	Compressed air - Part 1: Contaminants and purity classes	-	-



IEC 62271-4

Edition 2.0 2022-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**High-voltage switchgear and controlgear –
Part 4: Handling procedures for gases for insulation and/or switching**

**Appareillage à haute tension –
Partie 4: Procédures de manipulation des gaz pour l'isolation et/ou la
commutation**





THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2022 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 Secretariat
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.

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 once a month by email.

IEC 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: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

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.

IEC Products & Services Portal - products.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 300 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 19 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.



IEC 62271-4

Edition 2.0 2022-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**High-voltage switchgear and controlgear –
Part 4: Handling procedures for gases for insulation and/or switching**

**Appareillage à haute tension –
Partie 4: Procédures de manipulation des gaz pour l'isolation et/ou la
commutation**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.130.10; 29.130.99

ISBN 978-2-8322-4025-0

**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.....	15
INTRODUCTION.....	17
1 Scope.....	18
2 Normative references	18
3 Terms and definitions	19
3.1 General terms and definitions	19
3.2 Terms and definitions for SF ₆	24
3.3 Terms and definitions for SF ₆ mixtures	24
3.4 Terms and definitions for compressed air.....	25
3.5 Terms and definitions for natural-origin gases.....	26
3.6 Terms and definitions for C ₅ F ₁₀ O (C5-FK) in mixtures with N ₂ , CO ₂ , O ₂ (C5-FK mixtures)	27
3.7 Terms and definitions for C ₄ F ₇ N (C4-FN) in mixtures with N ₂ , CO ₂ , O ₂ (C4-FN mixtures)	28
4 Gas handling during installation, commissioning and after repair or overhaul on site.....	29
4.1 General.....	29
4.2 Evacuation, filling and quality checking.....	30
4.3 Topping-up of pre-filled gas compartments to the filling pressure/density for insulation and/or switching.....	33
4.4 Filling sealed pressure systems	35
5 Gas handling during normal service life	35
5.1 Topping-up of gas to the filling pressure/density for insulation and/or switching.....	35
5.2 Checking the quality of the gas	37
5.2.1 General	37
5.2.2 On-site measurement of the quality of gases with portable measurement equipment.....	37
5.2.3 Sampling and shipment of gases for off-site analysis.....	38
5.3 Rectifying the composition of a gas mixture	38
6 Recovery and reclaiming of gases during maintenance, repair, overhaul or dismantling on-site	39
6.1 General.....	39
6.2 Recovery and reclaiming of non-arced or normally arced gases from any gas compartment.....	39
6.3 Recovery and reclaiming from any gas compartment containing heavily arced gas.....	41
7 End-of-life of electric power equipment.....	43
7.1 General.....	43
7.2 End-of-life of controlled or closed pressure systems	44
7.3 End-of-life of sealed pressure systems.....	44
7.4 Gas recovery and reclaiming at the end-of-life of sealed pressure systems.....	45
7.5 Dismantling of electric power equipment (informative).....	49
Annex A (informative) Sulphur hexafluoride (SF ₆).....	50
A.1 Gas properties	50
A.2 Safety and first aid.....	50
A.2.1 General	50

A.2.2	Protection of personnel.....	51
A.2.3	Handling of contaminated safety equipment and tools.....	53
A.2.4	Pressurised equipment and tools or measuring devices.....	53
A.2.5	Personal safety and protective equipment.....	53
A.2.6	Facilities and services	54
A.2.7	Additional safety measures in case of sudden release of SF ₆	54
A.2.8	First aid equipment and treatment	54
A.3	Environmental impact.....	55
A.4	Training and certification.....	55
A.4.1	General	55
A.4.2	Training	56
A.4.3	Certification	57
A.5	Storage and transportation.....	57
A.5.1	General	57
A.5.2	Storage of containers filled with SF ₆	57
A.5.3	Transportation of containers filled with SF ₆	58
A.5.4	Storage and transportation of electric power equipment containing SF ₆	59
A.5.5	Responsibilities	60
A.6	Description of handling equipment	60
A.6.1	General	60
A.6.2	Filters	61
A.6.3	Vacuum pump.....	62
A.6.4	Main and vacuum compressors.....	63
A.6.5	Outlet compressor	63
A.6.6	External and internal gas storage containers	63
A.6.7	Evaporator and gas storage container heater.....	63
A.6.8	Gas piping and pipe junctions.....	64
A.6.9	Control instruments	64
A.6.10	Safety valves	64
A.6.11	Flexible hose connections.....	64
A.6.12	Portable devices for gas measurement	64
A.6.13	Gas leakage tester	66
A.6.14	Gas concentration alarm systems	66
A.6.15	Gas sampling cylinders.....	67
A.7	Reclaiming procedures	67
A.8	By-products	67
A.9	Procedure to evaluate the potential effects on health of by-products.....	67
A.10	Handling of SF ₆	67
A.10.1	General	67
A.10.2	Filling gas compartments with SF ₆	67
A.10.3	Topping-up gas compartments with SF ₆ to the filling pressure for insulation and/or switching.....	67
A.10.4	Checking the quality of SF ₆	67
A.10.5	Recovery and reclaim of SF ₆	67
A.11	Specifications for SF ₆ needed for filling or topping-up electric power equipment.....	67
Annex B (informative)	SF ₆ mixtures	68

B.1	Gas properties	68
B.1.1	General	68
B.1.2	Chemical properties	68
B.1.3	Physical properties	68
B.1.4	Insulating and switching behaviour	69
B.2	Safety and first aid	70
B.2.1	General	70
B.2.2	Protection of personnel	70
B.2.3	Handling of contaminated safety equipment and tools	70
B.2.4	Pressurised equipment and tools or measuring devices	70
B.2.5	Personal safety and protective equipment	70
B.2.6	Facilities and services	70
B.2.7	Additional safety measures in case of sudden release of SF ₆ mixtures	70
B.2.8	First aid equipment and treatment	70
B.3	Environmental impact	70
B.4	Training and certification	70
B.4.1	General	70
B.4.2	Training	71
B.4.3	Certification	71
B.5	Storage and transportation	71
B.5.1	General	71
B.5.2	Storage of containers filled with SF ₆ mixture	71
B.5.3	Transportation of containers filled with SF ₆ mixture	73
B.5.4	Storage and transportation of electric power equipment containing SF ₆ mixture	74
B.5.5	Responsibilities	75
B.6	Description of handling equipment	75
B.6.1	General	75
B.6.2	Filters	77
B.6.3	Vacuum pump	77
B.6.4	Main and vacuum compressors	77
B.6.5	Outlet compressor	77
B.6.6	External and internal gas storage containers	77
B.6.7	Evaporator and gas storage container heater	77
B.6.8	Gas piping and pipe junctions	77
B.6.9	Control instruments	77
B.6.10	Safety valves	77
B.6.11	Flexible hose connections	77
B.6.12	Portable devices for gas measurement	77
B.6.13	Gas leakage tester	78
B.6.14	Gas concentration alarm systems	78
B.6.15	Gas sampling cylinders	79
B.6.16	Gas mixing unit	79
B.7	Reclaiming procedures	79
B.8	By-products	79
B.9	Procedure to evaluate the potential effects on health of by-products	79
B.10	Handling of SF ₆ mixtures	79
B.10.1	General	79

B.10.2	Filling gas compartments with SF ₆ mixtures	80
B.10.3	Topping-up gas compartments with SF ₆ mixtures to the filling pressure for insulation and/or switching	80
B.10.4	Checking the quality of SF ₆ mixtures	81
B.10.5	Recovery and reclaim of SF ₆ mixtures	81
B.10.6	Rectifying the composition of SF ₆ mixtures	82
B.11	Specifications for SF ₆ mixtures needed for filling or topping-up electric power equipment	82
Annex C (informative)	Compressed air	83
C.1	Gas properties	83
C.1.1	General	83
C.1.2	Chemical properties	83
C.1.3	Physical properties	83
C.1.4	Insulating and switching behaviour	84
C.2	Safety and first aid	84
C.2.1	General	84
C.2.2	Protection of personnel	85
C.2.3	Handling of contaminated safety equipment and tools	86
C.2.4	Pressurised equipment and tools or measuring devices	86
C.2.5	Personal safety and protective equipment	87
C.2.6	Facilities and services	88
C.2.7	Additional safety measures in case of sudden release of compressed air	88
C.2.8	First aid equipment and treatment	88
C.3	Environmental impact	89
C.3.1	General	89
C.3.2	Ecotoxicology	89
C.3.3	Ozone depletion	90
C.3.4	Global warming/climate change (greenhouse effect)	90
C.3.5	Environmental impact of by-products	90
C.4	Training and certification	90
C.4.1	General	90
C.4.2	Training	90
C.4.3	Certification	91
C.5	Storage and transportation	92
C.5.1	General	92
C.5.2	Storage of containers filled with compressed air	92
C.5.3	Transportation of containers filled with compressed air	92
C.5.4	Storage and transportation of electrical power equipment containing compressed air	93
C.5.5	Responsibilities	93
C.6	Description of handling equipment	93
C.6.1	General	93
C.6.2	Filters	94
C.6.3	Vacuum pump	95
C.6.4	Main and vacuum compressors	96
C.6.5	Outlet compressor	96
C.6.6	External and internal gas storage containers	96
C.6.7	Evaporator and gas storage container heater	96

C.6.8	Gas piping and pipe junctions	96
C.6.9	Control instruments	96
C.6.10	Safety valves	97
C.6.11	Flexible hose connections	97
C.6.12	Portable devices for gas measurement	97
C.6.13	Gas leakage tester	98
C.6.14	Gas concentration alarm systems	98
C.6.15	Gas sampling cylinders	99
C.6.16	Gas purifying and filling device	99
C.7	Reclaiming procedures	100
C.7.1	General	100
C.7.2	Filtering recommendations	100
C.7.3	Transport of used compressed air in gas cylinders and containers by road	100
C.8	By-products	101
C.8.1	General	101
C.8.2	Decomposition of compressed air	101
C.8.3	Corrosion behaviour of compressed air and its by-products	102
C.8.4	Measures for the removal of by-products	102
C.8.5	Physiological characteristics of by-products	102
C.9	Procedure to evaluate the potential effects on health of by-products	103
C.9.1	General	103
C.9.2	Formation of by-products and health effects	104
C.10	Handling of compressed air	114
C.10.1	General	114
C.10.2	Filling gas compartments with compressed air	114
C.10.3	Topping-up gas compartments with compressed air to the filling pressure for insulation and/or switching	114
C.10.4	Checking the quality of compressed air	114
C.10.5	Recovery and reclaim of compressed air	115
C.11	Specifications for compressed air needed for filling or topping-up electric power equipment	115
Annex D (informative)	Natural-origin gases	116
D.1	Gas properties	116
D.1.1	General	116
D.1.2	Chemical properties	116
D.1.3	Physical properties	116
D.1.4	Insulating and switching behaviour	117
D.2	Safety and first aid	117
D.2.1	General	117
D.2.2	Protection of personnel	119
D.2.3	Handling of contaminated safety equipment and tools	120
D.2.4	Pressurised equipment and tools or measuring devices	120
D.2.5	Personal safety and protective equipment	120
D.2.6	Facilities and services	121
D.2.7	Additional safety measures in case of sudden release of natural-origin gases	122
D.2.8	First aid equipment and treatment	122
D.3	Environmental impact	123
D.3.1	General	123

D.3.2	Ecotoxicology	123
D.3.3	Ozone depletion	124
D.3.4	Global warming/climate change (greenhouse effect)	124
D.3.5	Environmental impact of by-products	124
D.4	Training and certification	124
D.4.1	General	124
D.4.2	Training	125
D.4.3	Certification	126
D.5	Storage and transportation	126
D.5.1	General	126
D.5.2	Storage of containers filled with natural-origin gases	126
D.5.3	Transportation of containers filled with natural-origin gases	127
D.5.4	Storage and transportation of electrical power equipment containing natural-origin gases	128
D.5.5	Responsibilities	129
D.6	Description of handling equipment	129
D.6.1	General	129
D.6.2	Filters	132
D.6.3	Vacuum pump	133
D.6.4	Main and vacuum compressors	133
D.6.5	Outlet compressor	133
D.6.6	External and internal gas storage container	134
D.6.7	Evaporator and gas storage container heater	134
D.6.8	Gas piping and pipe junctions	134
D.6.9	Control instruments	134
D.6.10	Safety valves	134
D.6.11	Flexible hose connections	134
D.6.12	Portable devices for gas measurement	135
D.6.13	Gas leakage tester	137
D.6.14	Gas concentration alarm systems	137
D.6.15	Gas sampling cylinders	137
D.6.16	Gas mixing unit	137
D.6.17	Gas filling unit	138
D.6.18	Gas recovery unit	138
D.6.19	Used gas storage and transportation devices	138
D.7	Reclaiming procedures	138
D.7.1	General	138
D.7.2	Filtering recommendations	139
D.7.3	Transport of used natural-origin gases in gas cylinders and containers by road	139
D.8	By-products	140
D.8.1	General	140
D.8.2	Decomposition of natural-origin gases	140
D.8.3	Corrosion behaviour of natural-origin gases and their by-products	140
D.8.4	Measures for the removal of by-products	141
D.8.5	Physiological characteristics of by-products	141
D.9	Procedure to evaluate the potential effects on health of gas components and by-products	142
D.9.1	General	142
D.9.2	Formation of by-products and health effects	142

D.10	Handling of natural-origin gases.....	152
D.10.1	General	152
D.10.2	Filling gas compartments with natural-origin gases	152
D.10.3	Topping-up gas compartments with natural-origin gases.....	153
D.10.4	Checking the quality of natural-origin gases.....	153
D.10.5	Recovery and reclaim of natural-origin gases	154
D.10.6	Rectifying the composition of natural-origin gas mixtures.....	154
D.11	Specifications for natural-origin gases needed for filling or topping-up electric power equipment	155
Annex E (informative)	C ₅ F ₁₀ O (C5-FK) in mixtures with N ₂ , CO ₂ , O ₂ (C5-FK mixtures)	156
E.1	Gas properties	156
E.1.1	General	156
E.1.2	Chemical properties.....	156
E.1.3	Physical properties	157
E.1.4	Insulating and switching behaviour	158
E.2	Safety and first aid.....	158
E.2.1	General	158
E.2.2	Protection of personnel.....	159
E.2.3	Handling of contaminated safety equipment and tools.....	161
E.2.4	Pressurised equipment and tools or measuring devices	161
E.2.5	Personal safety and protective equipment.....	162
E.2.6	Facilities and services	163
E.2.7	Additional safety measures in case of sudden release of C5-FK mixtures	163
E.2.8	First aid equipment and treatment	163
E.3	Environmental impact.....	164
E.3.1	General	164
E.3.2	Ecotoxicology	164
E.3.3	Ozone depletion	165
E.3.4	Global warming/climate change (greenhouse effect).....	165
E.3.5	Environmental impact of by-products	165
E.3.6	Decomposition by UV-light in the upper atmosphere	165
E.4	Training and certification.....	165
E.4.1	General	165
E.4.2	Training	166
E.4.3	Certification	167
E.5	Storage and transportation.....	167
E.5.1	General	167
E.5.2	Storage of containers filled with C5-FK or C5-FK mixtures.....	167
E.5.3	Transportation of containers filled with C5-FK or C5-FK mixtures	169
E.5.4	Storage and transportation of electrical power equipment containing C5-FK mixtures	171
E.5.5	Responsibilities	172
E.6	Description of handling equipment	172
E.6.1	General	172
E.6.2	Filters	174
E.6.3	Vacuum pump.....	175
E.6.4	Main and vacuum compressors.....	176

E.6.5	Outlet compressor	176
E.6.6	External and internal gas storage containers	176
E.6.7	Evaporator and gas storage container heater.....	176
E.6.8	Gas piping and pipe junctions	177
E.6.9	Control instruments	177
E.6.10	Safety valves	177
E.6.11	Flexible hose connections.....	177
E.6.12	Portable devices for gas measurement	177
E.6.13	Gas leakage tester	179
E.6.14	Gas concentration alarm systems	179
E.6.15	Gas sampling cylinders.....	179
E.6.16	Gas mixing unit.....	180
E.6.17	Gas filling unit	180
E.6.18	Gas recovery unit	180
E.6.19	Used gas storage and transportation devices.....	181
E.7	Reclaiming procedures	181
E.8	By-products	181
E.8.1	General	181
E.8.2	Decomposition of C5-FK mixtures.....	181
E.8.3	Corrosion behaviour of C5-FK mixtures and their by-products.....	183
E.8.4	Measures for the removal of by-products	183
E.8.5	Physiological characteristics of by-products.....	184
E.9	Procedure to evaluate the potential effects on health of gas components and by-products.....	184
E.9.1	General	184
E.9.2	Formation of by-products and health effects	185
E.10	Handling of C5-FK mixtures	194
E.10.1	General	194
E.10.2	Filling gas compartments with C5-FK mixtures.....	194
E.10.3	Topping-up gas compartments with C5-FK mixtures to the filling pressure for insulation and/or switching.....	195
E.10.4	Checking the quality of C5-FK mixtures	195
E.10.5	Recovery and reclaim of C5-FK mixtures	196
E.10.6	Rectifying the composition of C5-FK mixtures.....	196
E.11	Specifications for C5-FK mixtures needed for filling or topping-up electric power equipment	196
Annex F (informative)	C ₄ F ₇ N (C4-FN) in mixtures with N ₂ , CO ₂ , O ₂ (C4-FN mixtures)	197
F.1	Gas properties	197
F.1.1	General	197
F.1.2	Chemical properties.....	197
F.1.3	Physical properties	198
F.1.4	Insulating and switching behaviour	199
F.2	Safety and first aid.....	199
F.2.1	General	199
F.2.2	Protection of personnel.....	200
F.2.3	Handling of contaminated safety equipment and tools.....	202
F.2.4	Pressurised equipment and tools or measuring devices	202
F.2.5	Personal safety and protective equipment.....	202
F.2.6	Facilities and services	203

F.2.7	Additional safety measures in case of sudden release of C4-FN mixtures	203
F.2.8	First aid equipment and treatment	204
F.3	Environmental impact.....	204
F.3.1	General	204
F.3.2	Ecotoxicology	204
F.3.3	Ozone depletion	205
F.3.4	Global warming/climate change (greenhouse effect)	205
F.3.5	Environmental impact of by-products	205
F.3.6	Decomposition by UV-light in the upper atmosphere	206
F.4	Training and certification.....	206
F.4.1	General	206
F.4.2	Training	206
F.4.3	Certification	207
F.5	Storage and transportation.....	208
F.5.1	General	208
F.5.2	Storage of containers filled with C4-FN or C4-FN mixtures	208
F.5.3	Transportation of containers filled with C4-FN or C4-FN mixtures	210
F.5.4	Storage and transportation of electrical power equipment containing C4-FN mixtures	212
F.5.5	Responsibilities	213
F.6	Description of handling equipment	213
F.6.1	General	213
F.6.2	Filters	215
F.6.3	Vacuum pump.....	216
F.6.4	Main and vacuum compressors.....	217
F.6.5	Outlet compressor	217
F.6.6	External and internal gas storage containers	217
F.6.7	Evaporator and gas storage container heater.....	217
F.6.8	Gas piping and pipe junctions	218
F.6.9	Control instruments	218
F.6.10	Safety valves	218
F.6.11	Flexible hose connections.....	218
F.6.12	Portable devices for gas measurement	218
F.6.13	Gas leakage tester	220
F.6.14	Gas concentration alarm systems	220
F.6.15	Gas sampling cylinder	220
F.6.16	Gas mixing unit.....	221
F.6.17	Gas filling unit	221
F.6.18	Gas recovery unit	221
F.6.19	Used gas storage and transportation devices.....	222
F.7	Reclaiming procedures	222
F.8	By-products	222
F.8.1	General	222
F.8.2	Decomposition of C4-FN mixtures.....	222
F.8.3	Corrosion behaviour of C4-FN mixtures and their by-products	224
F.8.4	Measures for the removal of by-products	224
F.8.5	Physiological characteristics of by-products.....	225
F.9	Procedure to evaluate the potential effects on health of gas components and by-products.....	225

F.9.1	General	225
F.9.2	Formation of by-products and health effects	226
F.10	Handling of C4-FN mixtures	234
F.10.1	General	234
F.10.2	Filling gas compartments with C4-FN mixtures	234
F.10.3	Topping-up gas compartments with C4-FN mixtures to the filling pressure for insulation and/or switching	235
F.10.4	Checking the quality of C4-FN mixtures	236
F.10.5	Recovery and reclaim of C4-FN mixtures	236
F.10.6	Rectifying the composition of C4-FN mixtures	236
F.11	Specifications for C4-FN mixtures needed for filling or topping-up electric power equipment	236
	Bibliography	237
	Figure 1 – Evacuation, filling and checking of the quality of the gas after filling	31
	Figure 2 – Topping-up of pre-filled gas compartments to the filling pressure/density for insulation and/or switching	34
	Figure 3 – Topping-up of a gas to the filling pressure/density for insulation and/or switching	36
	Figure 4 – Example of recovery and reclaiming of non-arced or normally arced gas from any gas compartment	40
	Figure 5 – Example of recovery and reclaiming of heavily arced gas from any gas compartment	42
	Figure 6 – End-of-life of controlled or closed pressure systems	44
	Figure 7 – End-of-life of sealed pressure systems	45
	Figure 8 – Gas recovery and reclaiming at the end-of-life of sealed pressure systems	46
	Figure 9 – Dilution method	48
	Figure 10 – Dismantling of electric power equipment	49
	Figure A.1 – Pressure-temperature-density diagram for SF ₆	50
	Figure A.2 – Schematic view of an example of a handling equipment for SF ₆	61
	Figure B.1 – Schematic view of an example of a handling equipment for SF ₆ mixture	76
	Figure C.1 – Controlled release of compressed air	94
	Figure C.2 – Example of a gas filling and purifying device	99
	Figure D.1 – Schematic view of an example of a handling equipment for natural origin gases	131
	Figure E.1 – Structure of the C5-FK molecule	156
	Figure E.2 – Vapour pressure curve of C5-FK	157
	Figure E.3 – Schematic view of an example of a handling equipment for C5-FK mixture	173
	Figure F.1 – Structure of the C4-FN molecule	197
	Figure F.2 – Vapour pressure curve of C4-FN	198
	Figure F.3 – Schematic view of an example of a handling equipment for C4-FN mixture	214

Table 1 – Evacuation, filling and checking of the quality of the gas after filling	32
Table 2 – Topping-up of pre-filled gas compartments to the filling pressure/density for insulation and/or switching	35
Table 3 – Topping-up of a gas to the filling pressure/density for insulation and/or switching	37
Table 4 – Sampling and shipment of gases	38
Table 5 – Example of recovery and reclaiming of non-arced or normally arced gas from any gas compartment.....	41
Table 6 – Example of recovery and reclaiming of heavily arced gas from any gas compartment.....	43
Table 7 – Gas recovery at the end-of-life of sealed pressure systems	47
Table A.1 – Measures when working with SF ₆ electric power equipment.....	51
Table A.2 – Safety measures when opening or accessing gas compartments.....	52
Table A.3 – Examples of container types required for storage and transportation of SF ₆	58
Table A.4 – International regulations for shipment of SF ₆	59
Table A.5 – Gas measuring devices	64
Table B.1 – Main chemical characteristics of CF ₄ and N ₂	68
Table B.2 – Main physical characteristics of CF ₄ and N ₂	69
Table B.3 – Examples of container types required for storage and transportation of SF ₆ mixtures and their complementary gases	73
Table B.4 – International regulations for shipment of SF ₆ mixtures	74
Table B.5 – Gas measuring devices	78
Table C.1 – Main chemical characteristics of N ₂ and O ₂	83
Table C.2 – Typical physical characteristics of N ₂ and O ₂	84
Table C.3 – Measures when working with electric power equipment containing compressed air	85
Table C.4 – Safety measures when opening or accessing gas compartments	86
Table C.5 – Examples of container types required for storage and transportation of compressed air	92
Table C.6 – International regulations for shipment of compressed air.....	93
Table C.7 – Typical filter types used during release of compressed air to the atmosphere.....	95
Table C.8 – Gas measuring devices	97
Table C.9 – Exemplary filtering methods	100
Table C.10 – Typical adsorbents for various compressed air contaminants	100
Table C.11 – OELs for NO ₂ , NO, O ₃ and HNO ₃	106
Table C.12 – Example calculation of a normal leakage	109
Table C.13 – Example calculation of an abnormal leakage.....	111
Table C.14 – Example calculation for maintenance	112
Table D.1 – Main chemical characteristics of N ₂ , O ₂ and CO ₂	116
Table D.2 – Typical physical characteristics of N ₂ , O ₂ and CO ₂	117
Table D.3 – Measures when working with electric power equipment containing natural-origin gases	118
Table D.4 – Safety measures when opening or accessing gas compartments	119

Table D.5 – Examples of container types required for storage and transportation of natural-origin gases	127
Table D.6 – International regulations for shipment of natural-origin gases.....	128
Table D.7 – Typical filter types used during release of natural-origin gases to the atmosphere.....	132
Table D.8 – Gas measuring devices.....	135
Table D.9 – Exemplary filtering operations.....	139
Table D.10 – Typical adsorbents for various contaminants of natural-origin gases	139
Table D.11 – OELs for NO ₂ , NO, O ₃ , CO and HNO ₃	144
Table D.12 – Example calculation of a normal leakage	147
Table D.13 – Example calculation of an abnormal leakage.....	149
Table D.14 – Example calculation for maintenance	150
Table E.1 – Main chemical characteristics C5-FK	157
Table E.2 – Main physical characteristics of C5-FK.....	158
Table E.3 – Measures when working with electric power equipment containing C5-FK mixtures.....	159
Table E.4 – Safety measures when opening or accessing gas compartments.....	160
Table E.5 – Methods for storage of C5-FK	168
Table E.6 – Examples of container types required for storage / transportation of C5-FK	168
Table E.7 – Methods for storage of C5-FK mixtures	169
Table E.8 – Examples of container types required for storage / transportation of C5-FK mixtures.....	169
Table E.9 – International regulations for shipment of C5-FK.....	170
Table E.10 – International regulations for shipment of C5-FK mixtures	171
Table E.11 – Typical filter types	175
Table E.12 – Gas measuring devices	177
Table E.13 – OELs and LC50 values for C5-FK mixtures by-products	182
Table E.14 – Example calculation of a normal leakage.....	189
Table E.15 – Example calculation of an abnormal leakage.....	191
Table E.16 – Example calculation for maintenance	192
Table E.17 – TWA values of gas components	193
Table F.1 – Main chemical characteristics C4-FN.....	198
Table F.2 – Main physical characteristics of C4-FN.....	199
Table F.3 – Measures when working with electric power equipment containing C4-FN mixtures.....	200
Table F.4 – Safety measures when opening or accessing gas compartments.....	201
Table F.5 – Methods for storage of C4-FN	208
Table F.6 – Examples of container types required for storage / transportation of C4-FN	208
Table F.7 – Methods for storage of C4-FN mixtures	209
Table F.8 – Examples of container types required for storage and transportation of C4-FN mixtures	210
Table F.9 – International regulations for shipment of C4-FN.....	210
Table F.10 – International regulations for shipment of C4-FN mixtures	212
Table F.11 – Typical filter types	216
Table F.12 – Gas measuring devices	218

Table F.13 – OELs and LC50 values for C4-FN mixtures by-products	223
Table F.14 – Example calculation of a normal leakage.....	230
Table F.15 – Example calculation of an abnormal leakage	231
Table F.16 – Example calculation for maintenance	232
Table F.17 – TWA values of gas components	233

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –**Part 4: Handling procedures for gases for insulation and/or switching****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.

IEC 62271-4 has been prepared by IEC technical committee 17: High-voltage switchgear and controlgear. It is an International Standard.

This second edition cancels and replaces the first edition of IEC 62271-4 published in 2013. This edition constitutes a technical revision.

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

- a) title has been modified;
- b) handling procedures of alternatives to SF₆, which are used for insulation and/or switching, are added;
- c) the main clauses are independent from the type of gas;
- d) for each gas a separate annex describes gas specific information, handling procedures, safety measure, etc.;

- e) information about SF₆ (former Annex E) and about environmental effects of SF₆ and its mixtures (former Annex F) has been moved to IEC 60376;
- f) information about by-products of SF₆ and its mixtures (former Annex G), the procedure for evaluating the potential effects on health of by-products of SF₆ and its mixtures (former Annex H) and the cryogenic reclaim of SF₆ (former Annex I) have been moved to IEC 60480.

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

Draft	Report on voting
17/1124/FDIS	17/1125/RVD

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

The language used for the development of this International Standard is English.

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

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under 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
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this document 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.

INTRODUCTION

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document can involve the use of a patent. IEC takes no position concerning the evidence, validity, and scope of this patent right.

The holder of this patent right has assured IEC that s/he is willing to negotiate licences under reasonable and non-discriminatory terms and conditions with applicants throughout the world. In this respect, the statement of the holder of this patent right is registered with IEC. Information can be obtained from the patent database available at <http://patents.iec.ch>.

Attention is drawn to the possibility that some of the elements of this document can be the subject of patent rights other than those in the patent database. IEC shall not be held responsible for identifying any or all such patent rights.

This document does not purport to address all the safety problems associated with its use. It is the responsibility of the user of this document to establish appropriate health and safety practices and determine the applicability of regulatory limitations prior to use.

The gases for insulation and/or switching which are the subjects of this document should be handled in compliance with local regulations, suppliers safety data-sheets, the operating instruction manual of the manufacturer and the safety guidance of the user of the electric power equipment.

Considering the limited information for some of the data which appear in the informative Annex E and Annex F, the reader should be aware that the information related with possible by-products and their possible toxicological effects on health and on the environment is still a matter of study.

Within IEC TC 10 new standards about specifications of technical grade (IEC 63360) and re-use (IEC 63359) for alternatives to SF₆ are being prepared. Therefore, in a later revision of this standard, some of the information will be moved to these new standards, similarly as it has been done for SF₆ and SF₆ mixtures.

HIGH-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 4: Handling procedures for gases for insulation and/or switching

1 Scope

This part of IEC 62271 applies to the procedures for handling of gases for insulation and/or switching during installation, commissioning, repair, overhaul, normal and abnormal operations and disposal at the end-of-life of electric power equipment.

These procedures are regarded as minimum requirements to ensure the reliability of electric power equipment, the safety of personnel working with these gases and to minimize the impact on the environment. Additional requirements could be given or specified in the operating instruction manual of the manufacturer.

For each gas, which is known to be used in electric power equipment at the date of the publication of this document, a separate annex describes specifications, handling procedures, safety measures, etc. For gases not covered by these annexes the electric power equipment manufacturer should provide the information needed, following the structure of these annexes. Such gases should also be described in a next edition or in amendments to this edition.

NOTE 1 For the use of this document, high-voltage (HV) is defined as the rated voltage above 1 000 V. However, the term medium-voltage (MV) is commonly used for distribution systems with voltages above 1 kV and generally applied up to and including 52 kV.

NOTE 2 Throughout this document, the term “pressure” stands for “absolute pressure”.

NOTE 3 In this document, percentages of gaseous components, contaminants and by-products, are always percentages per volume, measured at 20 °C, if not otherwise indicated.

NOTE 4 Reference is also made to CIGRE Brochure 802 [1] ¹.

NOTE 5 For further details on gases, e.g. ecotoxicology, also refer to the chemical database of the European Chemicals Agency, ECHA (www.echa.europa.eu), which takes the actual tonnage band into consideration.

NOTE 6 If gases for insulation and/or switching are regulated, their designation and regulation origin can be found in the IEC 62474 database (available at <https://std.iec.ch/iec62474> [26]).

NOTE 7 When reference to circuit-breakers is made, only gas circuit-breakers are of interest. When vacuum circuit-breakers are of interest, they are explicitly mentioned.

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 60050-212:2010, *International Electrotechnical Vocabulary (IEV) – Part 212: Electrical insulating solids, liquids and gases* (available at www.electropedia.org)
IEC 60050-212:2010/AMD1:2015
IEC 60050-212:2010/AMD2:2015
IEC 60050-212:2010/AMD3:2020

¹ Numbers in square brackets refer to the Bibliography.

IEC 60050-426:2020, *International Electrotechnical Vocabulary (IEV) – Part 426: Explosive atmospheres* (available at www.electropedia.org)

IEC 60050-441:1984, *International Electrotechnical Vocabulary (IEV) – Part 441: Switchgear, controlgear and fuses* (available at www.electropedia.org)
IEC 60050-441:1984/AMD1:2000

IEC 60335-2-69:2021, *Household and similar electrical appliances – Safety – Part 2-69: Particular requirements for wet and dry vacuum cleaners, including power brush, for commercial use*

IEC 60376:2018, *Specification of technical grade sulphur hexafluoride (SF₆) and complementary gases to be used in its mixtures for use in electrical equipment*

IEC 60480:2019, *Specifications for the re-use of sulphur hexafluoride (SF₆) and its mixtures in electrical equipment*

IEC 62271-1:2017, *High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear*
IEC 62271-1:2017/AMD1:2021

ISO 8573-1:2010, *Compressed air – Part 1: Contaminants and purity classes*

koniec náhľadu – text ďalej pokračuje v platenej verzii STN