

INTERNATIONAL STANDARD



This full version of IEC 60335-2-40:2024 includes the content of the references made to IEC 60335-1:2020

**Household and similar electrical appliances – Safety –
Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2024 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.

IEC Secretariat
3, rue de Varembe
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 It also gives information on projects, replaced and withdrawn publications.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, graphical symbols and the glossary. 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 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IECNORM.COM : Click to view the full text of IEC 60352-40:2024 EXV



IEC 60335-2-40

Edition 8.0 2024-12
EXTENDED VERSION

INTERNATIONAL STANDARD



This full version of IEC 60335-2-40:2024 includes the content of the references made to IEC 60335-1:2020

**Household and similar electrical appliances – Safety –
Part 2-40: Particular requirements for electrical heat pumps, air-conditioners
and dehumidifiers**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 23.120

ISBN 978-2-8327-0103-4

Warning! Make sure that you obtained this publication from an authorized distributor.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC 60335-1 Edition 6.0 2020-09

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 1: General requirements

INTERPRETATION SHEET 1

This interpretation sheet has been prepared by IEC technical committee 61: Safety of household and similar electrical appliances.

The text of this Interpretation Sheet is based on the following documents:

Draft	Report on voting
61/5999/DISH	61/6009/RVDISH

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

INTRODUCTION

Edition 6 of IEC 60335-1:2020 defines and introduces requirements for a detachable power supply part of an appliance. In the document, 24.2 prohibits the use of a power supply in a flexible cord.

QUESTION:

Does Subclause 24.2 prohibit the use of a detachable power supply part?

ANSWER

No, a "detachable power supply part" is a defined term and is not captured by the term "power supply" as used in Subclause 24.2.

NOTE A detachable power supply part is captured by the defined term when the output of the power supply part is detachable from the class III construction part of the appliance at:

- the power supply part, or
- the class III construction part of the appliance.

However, the supply cord (if any) does not have to be detachable from the detachable power supply part.

CONTENTS

FOREWORD.....	7
INTRODUCTION to IEC 60335-1:2020.....	10
INTRODUCTION to IEC 60335-2-40:2024.....	12
1 Scope.....	13
2 Normative references.....	14
3 Terms and definitions.....	20
4 General requirement.....	38
5 General conditions for the tests.....	38
6 Classification.....	43
7 Marking and instructions.....	44
8 Protection against access to live parts.....	57
9 Starting of motor-operated appliances.....	59
10 Power input and current.....	59
11 Heating.....	62
12 Charging of metal-ion batteries.....	69
13 Leakage current and electric strength at operating temperature.....	70
14 Transient overvoltages.....	73
15 Moisture resistance.....	74
16 Leakage current and electric strength.....	75
17 Overload protection of transformers and associated circuits.....	77
18 Endurance.....	78
19 Abnormal operation.....	78
20 Stability and mechanical hazards.....	94
21 Mechanical strength.....	95
22 Construction.....	98
23 Internal wiring.....	122
24 Components.....	124
25 Supply connection and external flexible cords.....	130
26 Terminals for external conductors.....	138
27 Provision for earthing.....	141
28 Screws and connections.....	143
29 Clearances, creepage distances and solid insulation.....	145
30 Resistance to heat and fire.....	154
31 Resistance to rusting.....	158
32 Radiation, toxicity and similar hazards.....	159
Annex A (informative) Routine tests.....	178
Annex B (normative) Battery-operated appliances, separable batteries and detachable batteries for battery-operated appliances.....	180
Annex C (normative) Ageing test on motors.....	201
Annex D (normative) Thermal motor protectors.....	202
Annex E (normative) Needle-flame test.....	203
Annex F (normative) Capacitors.....	204

Annex G (normative) Safety isolating transformers	206
Annex H (normative) Switches	207
Annex I (normative) Motors having basic insulation that is inadequate for the rated voltage of the appliance	209
Annex J (normative) Coated printed circuit boards	210
Annex K (informative) Overvoltage categories	211
Annex L (informative) Guidance for the measurement of clearances and creepage distances	212
Annex M (informative) Pollution degree	215
Annex N (normative) Proof tracking test	216
Annex O (informative) Selection and sequence of the tests of Clause 30	217
Annex P (informative) Guidance for the application of this standard to appliances used in tropical climates	222
Annex Q (informative) Sequence of tests for the evaluation of electronic circuits	224
Annex R (normative) Software evaluation	227
Annex S (informative) Guidance for the application of this standard on measurement of power input and current based on the requirements of 10.1 and 10.2 concerning the representative period	241
Annex T (normative) UV-C radiation effect on non-metallic materials	242
Annex U (normative) Appliances intended for remote communication through public networks	245
Annex V (informative) Examples for operating temperatures of the appliance	249
Annex W (normative) Selected information about refrigerants	250
Annex X (informative) Transportation, marking and storage for units that employ flammable refrigerants	254
Annex Y (normative) Requirements for installation, service, maintenance and repair, and decommissioning instructions of appliances using flammable refrigerants	255
Annex Z (normative) Pressure tests	264
Annex AA (normative) Leak simulation tests	266
Annex BB (normative) Charge limits, ventilation requirements and requirements for secondary circuits	268
Annex CC (informative) Competence of service personnel	302
Annex DD (Void)	305
Annex EE (normative) Allowable openings of relays and similar components to prevent ignition of A2L refrigerants	306
Annex FF (normative) Test method for hot surface ignition temperature for A2L	308
Annex GG (Void)	312
Annex HH (normative) Refrigerant sensor location confirmation test	313
Annex II (normative) Flame arrest enclosure verification test for A2L refrigerants	316
Annex JJ (Void)	318
Annex KK (normative) Leak detection system confirmation test for flammable refrigerants	319
Annex LL (normative) Methods for determining releasable charge	325
Bibliography	333
Index of defined terms	336

Figure 1 – Circuit diagram for leakage current measurement at operating temperature for single-phase connection of class II appliances and for parts of class II construction 161

Figure 2 – Circuit diagram for leakage current measurement at operating temperature for single-phase connection of other than class II appliances or parts of class II construction	162
Figure 3 – Circuit diagram for leakage current measurement at operating temperature for three-phase with neutral class II appliances and for parts of class II construction	163
Figure 4 – Circuit diagram for leakage current measurement at operating temperature for three-phase with neutral appliances other than those of class II or parts of class II construction	164
Figure 5 – Small part	165
Figure 6 – Example of an electronic circuit with low-power points	165
Figure 7 – Test finger nail	166
Figure 8 – Flexing test apparatus	167
Figure 9 – Constructions of cord anchorages	168
Figure 10 – An example of parts of an earthing terminal	169
Figure 11 – Examples of clearances	170
Figure 12 – Example of the placement of the cylinder	171
Figure 13 – Small parts cylinder	172
Figure 14 – Example of a specified operating region of a lithium-ion cell during charging	173
Figure 101 – Example of label for field charged units	173
Figure 102 – Arrangement for heating test of appliances with supplementary air heater	175
Figure 103 – Supply circuit for locked-rotor test of a motor of the single-phase type	176
Figure 104 – Power spectral density profile for vibration test in 21.101	176
Figure 105 – Dimensional details for the weight in the area of the pressure ball	176
Figure 106 – Measurement before and after the test	177
Figure B.1 – Examples of battery-operated appliance constructions and application of normative Annex B (1 of 2)	198
Figure B.2 – Examples of correct polarity connection marking representing three batteries	200
Figure L.1 – Sequence for the determination of clearances	212
Figure L.2 – Sequence for the determination of creepage distances	213
Figure L.3 – Measurement of clearances	214
Figure O.1 – Tests for resistance to heat	217
Figure O.2 – Selection and sequence of tests for resistance to fire in hand-held appliances	218
Figure O.3 – Selection and sequence of tests for resistance to fire in attended appliances	218
Figure O.4 – Selection and sequence of tests for resistance to fire in unattended appliances	219
Figure O.5 – Some applications of the term "within a distance of 3 mm"	221
Figure Q.1 – Flowchart outlining the sequence of tests for the evaluation of electronic circuits (1 of 2)	225
Figure S.1 – Flowchart giving guidance on measurement of power input and current concerning the representative period	241
Figure GG.1 – Unventilated area	299
Figure GG.2 – Mechanical ventilation	299
Figure GG.3 – Relevant heights h_{inst} , h_0 and h_{rel} for calculation of A_{min} and m_{max}	300

Figure GG.4 – Airflow direction	301
Figure KK.1 – Front view of test apparatus labels	308
Figure KK.2 – Test apparatus with dimensions.....	309
Figure KK.3 – Top view of test apparatus.....	310
Table 1 – Power input deviation	60
Table 2 – Current deviation.....	61
Table 3 – Maximum normal temperature rises.....	66
Table 4 – Voltage for electric strength test.....	73
Table 5 – Characteristics of high-voltage sources	73
Table 6 – Impulse test voltage	74
Table 7 – Test voltages.....	77
Table 8 – Maximum winding temperature	81
Table 9 – Maximum abnormal temperature rise.....	87
Table 101 – Power spectral density profile for vibration test.....	97
Table 10 – Dimensions of cables and conduits.....	131
Table 11 – Minimum cross-sectional area of conductors	133
Table 12 – Pull force and torque	136
Table 13 – Nominal cross-sectional area of conductors	140
Table 14 – Torque for testing screws and nuts.....	144
Table 15 – Rated impulse voltage	146
Table 16 – Minimum clearances.....	146
Table 17 – Minimum creepage distances for basic insulation	150
Table 18 – Minimum creepage distances for functional insulation	152
Table 19 – Minimum thickness for accessible parts of reinforced insulation consisting of a single layer	153
Table 102 – UV-C spectral irradiance measurement location	160
Table A.1 – Test voltages.....	179
Table B.1 – Artificial source characteristics.....	182
Table B.2 – Total area of openings for metal-ion cells.....	190
Table B.3 – Volume of air injected at 2 070 kPa.....	190
Table C.1 – Test conditions	201
Table R.1 – General fault/error conditions.....	229
Table R.2 – Specific fault/error conditions.....	231
Table R.3 – Semi-formal methods	237
Table R.4 – Software architecture specification	237
Table R.5 – Module design specification	238
Table R.6 – Design and coding standards.....	239
Table R.7 – Software safety validation	239
Table T.1 – Minimum property retention limits after UV-C exposure	243
Table T.2 – Minimum electric strength for internal wiring after UV-C exposure	244
Table U.1 – Examples of acceptable measures against unauthorised access and transmission fault/error modes.....	247
Table AA.1 – Examples for operating temperatures of the appliance.....	249

Table BB.1 – Selected information about refrigerants	250
Table DD.1 – Mandatory clauses in each of the instructions	255
Table GG.1 – Outline of Annex GG	269
Table GG.2 – Circulation airflow	274
Table GG.3 – Appliance with packaging	281
Table GG.4 – Appliance without packaging	281
Table GG.5 – Minimum air velocity	294
Table GG.6 – Refrigerant leak rate ($\dot{m}_{\text{leak}}$)	297

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

This extended version (EXV) of the official IEC Standard provides the user with the full content of the Standard.

IEC 60335-2-40:2024 EXV includes the content of IEC 60335-2-40:2024, and the references made to IEC 60335-1:2020.

The specific content of IEC 60335-2-40:2024 is displayed on a blue background.

IEC 60335-2-40 has been prepared by subcommittee 61D: Appliances for air-conditioning for household and similar purposes, of IEC technical committee 61: Safety of household and similar electrical appliances. It is an International Standard.

This eighth edition cancels and replaces the seventh edition published in 2022. This edition constitutes a technical revision.

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

- a) Clause 12 : Part 1, Clause 12 has been made applicable;
- b) Clause 19: requirement added for **double wall heat exchangers** to be resistant against freezing;
- c) Clause 20: requirement modified for when to apply test probe 18;
- d) Clause 21: requirement added for **double wall heat exchangers** to resistant against the pressure of the refrigerant if one of the walls fails;
- e) Clause 22: requirement modified to reflect that appliances can operate continuously and can be operated remotely without giving rise to a hazard, and requirement added for **double wall heat exchangers** to be constructed to avoid refrigerant leaking into the secondary circuit;
- f) Annex LL has been deleted and replaced by a reference to IEC TS 63542:2024.

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

Draft	Report on voting
61D/538/FDIS	61D/542/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.

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/publications.

A list of all parts of the IEC 60335 series, under the general title: *Household and similar electrical appliances – Safety*, can be found on the IEC website.

This part 2 is to be used in conjunction with the latest edition of IEC 60335-1 and its amendments unless that edition precludes it; in that case, the latest edition that does not preclude it is used. It was established on the basis of the sixth edition (2020) of that standard.

NOTE 1 When "Part 1" is mentioned in this standard, it refers to IEC 60335-1.

This part 2-40 supplements or modifies the corresponding clauses in IEC 60335-1, so as to convert that publication into the IEC standard: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers.

When a particular subclause of Part 1 is not mentioned in this part 2, that subclause applies as far as is reasonable. When this standard states "addition", "modification" or "replacement", the relevant text in Part 1 is to be adapted accordingly.

NOTE 2 The following numbering system is used:

- subclauses, tables and figures that are numbered starting from 101 are additional to those in Part 1;

- unless notes are in a new subclause or involve notes in Part 1, they are numbered starting from 101, including those in a replaced clause or subclause;
- additional annexes are lettered AA, BB, etc.

NOTE 3 The following print types are used:

- requirements: in roman type;
- *test specifications: in italic type;*
- notes: in small roman type.

Words in **bold** in the text are defined in Clause 3. When a definition concerns an adjective, the adjective and associated noun are also in bold.

The following differences of a less permanent nature exist in the countries indicated below:

- 6.1: Class 0I appliances are allowed (Japan).
- 11.8: The temperature of the wooden walls in the test casing is limited to 85 °C (Sweden).

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, or
- revised.

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 to IEC 60335-1:2020

It has been assumed in the drafting of this International Standard that the execution of its provisions is entrusted to appropriately qualified and experienced persons.

Guidance documents concerning the application of the safety requirements for appliances can be accessed via TC 61 supporting documents on the IEC website –

www.iec.ch/tc61/supportingdocuments

This information is given for the convenience of users of this International Standard and does not constitute a replacement for the normative text in this standard.

This standard recognizes the internationally accepted level of protection against hazards such as electrical, mechanical, thermal, fire and radiation of appliances when operated as in normal use taking into account the manufacturer's instructions. It also covers abnormal situations that can be expected in practice and takes into account the way in which electromagnetic phenomena can affect the safe operation of appliances.

This standard takes into account the requirements of IEC 60364 as far as possible so that there is compatibility with the wiring rules when the appliance is connected to the supply mains. However, national wiring rules may differ.

If the functions of an appliance are covered by different parts 2 of IEC 60335, the relevant part 2 is applied to each function separately, as far as is reasonable. If applicable, the influence of one function on the other is taken into account.

Throughout this publication, when "part 2" is mentioned, it refers to the relevant part of IEC 60335.

When a part 2 standard does not include additional requirements to cover hazards dealt with in Part 1, Part 1 applies.

NOTE 1 This means that the technical committees responsible for the part 2 standards have determined that it is not necessary to specify particular requirements for the appliance in question over and above the general requirements.

This standard is a product family standard dealing with the safety of appliances and takes precedence over horizontal and generic standards covering the same subject.

NOTE 2 Horizontal publications, basic safety publications and group safety publications covering a hazard are not applicable since they have been taken into consideration when developing the general and particular requirements for the IEC 60335 series of standards.

Individual countries may wish to consider the application of this standard, as far as is reasonable, to appliances not mentioned in a part 2, and to appliances designed on new principles. In this case, consideration should be given to defining normal operation, specifying the classification of the appliance according to Clause 6 and specifying whether the appliance is operated attended or unattended. Consideration should also be given to particular categories of likely users and to related specific risks such as access to live parts, hot surfaces or hazardous moving parts.

An appliance that complies with the text of this standard will not necessarily be considered to comply with the safety principles of this standard if, when examined and tested, it is found to have other features which impair the level of safety covered by these requirements.

An appliance employing materials or having forms of construction differing from those detailed in the requirements of this standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be considered to comply with this standard.

NOTE 3 Standards dealing with non-safety aspects of household appliances are:

- IEC standards published by TC 59 concerning methods of measuring performance;
- CISPR 11, CISPR 14-1 and relevant IEC 61000-3 series standards concerning electromagnetic emissions;
- CISPR 14-2 concerning electromagnetic immunity;
- IEC standards published by TC 111 concerning environmental matters.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

INTRODUCTION to IEC 60335-2-40:2024

It has been assumed in the drafting of this International Standard that the execution of its provisions is entrusted to appropriately qualified and experienced persons.

Guidance documents concerning the application of the safety requirements for appliances can be accessed via TC 61 supporting documents on the IEC website

<https://www.iec.ch/tc61/supportingdocuments>

This information is given for the convenience of users of this International Standard and does not constitute a replacement for the normative text in this standard.

This standard recognizes the internationally accepted level of protection against hazards such as electrical, mechanical, thermal, fire and radiation of appliances when operated as in normal use taking into account the instructions. It also covers abnormal situations that can be expected in practice.

This standard takes into account the requirements of IEC 60364 as far as possible so that there is compatibility with the wiring rules when the appliance is connected to the supply mains. However, national wiring rules can differ.

If an appliance within the scope of this standard also incorporates functions that are covered by another part 2 of IEC 60335, the relevant part 2 is applied to each function separately, as far as is reasonable. If applicable, the influence of one function on the other is taken into account.

When a part 2 standard does not include additional requirements to cover hazards dealt with in Part 1, Part 1 applies.

NOTE 1 This means that the technical committees responsible for the part 2 standards have determined that it is not necessary to specify particular requirements for the appliance in question over and above the general requirements.

This standard is a product family standard dealing with the safety of appliances and takes precedence over horizontal and generic standards covering the same subject.

NOTE 2 Horizontal publications, basic safety publications and group safety publications covering a hazard are not applicable since they have been taken into consideration when developing the general and particular requirements for the IEC 60335 series of standards.

An appliance that complies with the text of this standard will not necessarily be considered to comply with the safety principles of the standard if, when examined and tested, it is found to have other features that impair the level of safety covered by these requirements.

An appliance employing materials or having forms of construction differing from those detailed in the requirements of this standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be considered to comply with the standard.

NOTE 3 Standards dealing with non-safety aspects of household appliances are:

- IEC standards published by TC 59 concerning methods of measuring performance;
- CISPR 11, CISPR 14-1 and relevant IEC 61000-3 series standards concerning electromagnetic emissions;
- CISPR 14-2 concerning electromagnetic immunity;
- IEC standards published by TC 111 concerning environmental matters.

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers

1 Scope

This part of IEC 60335 deals with the safety of electric **heat pumps**, **sanitary hot water heat pumps** and **air-conditioners**, incorporating motor-compressors as well as **hydronic fan coils units**, **dehumidifiers** (with or without motor-compressors), **thermoelectric heat pumps** and **partial units**, their maximum **rated voltage** being not more than 300 V for single phase appliances and 600 V for other appliances including direct current (DC) supplied appliances and **battery-operated appliances**.

Appliances not intended for normal household use but which nevertheless can be a source of danger to the public, such as appliances intended to be used by laypersons in shops, in light industry and on farms, are within the scope of this standard.

The appliances referenced above can consist of one or more factory-made assemblies. If provided in more than one assembly, the separate assemblies are used together, and the requirements are based on the use of matched assemblies.

NOTE 101 A definition of 'motor-compressor' is given in IEC 60335-2-34, which includes the statement that the term motor-compressor is used to designate either a hermetic motor-compressor or semi-hermetic motor-compressor.

NOTE 102 Requirements for containers intended for storage of the heated water included in **sanitary hot water heat pumps** are, in addition, covered by IEC 60335-2-21.

This standard does not take into account refrigerants other than group A1, A2L, A2 and A3 as defined by ISO 817. **Flammable refrigerants** are limited to those of a molar mass of more than or equal to 42 kg/kmol based on WCF (worst case formulation) as specified in ISO 817.

As far as practical, this standard deals with common hazards presented by appliances that are encountered in normal use and assumes that installation, servicing, decommissioning, and disposal are safely handled by competent persons and accidental release of refrigerants is avoided. However, it does not specify the criteria to ensure competence of persons during installation, servicing and disposal. Safety requirements during disposal are not specified in this standard.

NOTE 103 Annex HH provides informative requirements on competence of personnel. Criteria for competence of personnel for the purpose of certification schemes can be found in ISO 22712.

Unless specifications are covered by this standard, including the annexes, requirements for refrigerating safety are covered by:

- ISO 5149-1:2014, ISO 5149-1:2014/AMD1:2015, and ISO 5149-1:2014/AMD2:2021,
- ISO 5149-2:2014 and ISO 5149-2:2014/AMD1:2020,
- ISO 5149-3:2014 and ISO 5149-3:2014/AMD1:2021.

Supplementary heaters, or a provision for their separate installation, are within the scope of this standard, but only heaters which are designed as a part of the appliance package, the controls being incorporated in the appliance.

NOTE 104 Attention is drawn to the fact that

- for appliances intended to be used in vehicles or on-board ships or aircraft, additional requirements can be necessary;
- in many countries, additional requirements are specified, for example, by the national health authorities responsible for the protection of labour and the national authorities responsible for storage, transportation, building constructions and installations.

This standard does not apply to

- humidifiers intended for use with heating and cooling equipment (IEC 60335-2-88);
- appliances designed exclusively for industrial processing;
- appliances intended to be used in locations where special conditions prevail, such as the presence of a corrosive or explosive atmosphere (dust, vapour or gas).

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 60034-1, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60061-1, *Lamp caps and holders together with gauges for the control of interchangeability and safety – Part 1: Lamp caps*

IEC 60065:2014, *Audio, video and similar electronic apparatus – Safety requirements*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-31, *Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens*

IEC 60068-2-52, *Environmental testing – Part 2: Tests – Test Kb: Salt mist, cyclic (sodium, chloride solution)*

IEC 60068-2-75, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*

IEC 60079-7:2015, *Explosive atmospheres – Part 7: Equipment protection by increased safety "e"*

IEC 60079-7:2015/AMD1:2017

IEC 60079-14, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*

IEC 60079-15:2017, *Explosive atmospheres – Part 15: Equipment protection by type of protection "n"*

IEC TR 60083, *Plugs and socket-outlets for domestic and similar general use standardized in member countries of IEC*

IEC 60085:2007, *Electrical insulation – Thermal evaluation and designation*

IEC 60112:2003, *Method for the determination of the proof and the comparative tracking indices of solid insulating materials*
IEC 60112:2003/AMD1:2009¹

IEC 60127 (all parts), *Miniature fuses*

IEC 60227 (all parts), *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V*

IEC 60227-5:2011, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V – Part 5: Flexible cables (cords)*

IEC 60238, *Edison screw lampholders*

IEC 60245 (all parts), *Rubber insulated cables – Rated voltages up to and including 450/750 V*

IEC 60252-1:2010, *AC motor capacitors – Part 1: General – Performance, testing and rating – Safety requirements – Guidance for installation and operation*
IEC 60252-1:2010/AMD1:2013²

IEC 60309-2, *Plugs, socket-outlets and couplers for industrial purposes – Part 2: Dimensional interchangeability requirements for pin and contact-tube accessories*

IEC 60320 (all parts), *Appliance couplers for household and similar general purposes*

IEC 60320-1, *Appliance couplers for household and similar general purposes – Part 1: General requirements*

IEC 60320-2-3, *Appliance couplers for household and similar general purposes – Part 2-3: Appliance couplers with a degree of protection higher than IPX0*

IEC 60320-3, *Appliance couplers for household and similar general purposes – Part 3: Standard sheets and gauges*

IEC 60335-2-34:2021, *Household and similar electrical appliances – Safety – Part 2-34: Particular requirements for motor-compressors*

IEC 60335-2-51, *Household and similar electrical appliances – Safety – Part 2-51: Particular requirements for stationary circulation pumps for heating and service water installations*

IEC 60384-14:2013, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification – Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*
IEC 60384-14:2013/AMD1:2016³

IEC 60417, *Graphical symbols for use on equipment*

IEC 60445:2017, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors*

¹ There exists a consolidated edition 4.1:2009 that includes edition 4 and its Amendment 1.

² There exists a consolidated edition 2.1:2013 that includes edition 2 and its Amendment 1.

³ There exists a consolidated edition 4.1:2016 that includes edition 4 and its Amendment 1.

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 60529:1989/AMD1:1999

IEC 60529:1989/AMD2:2013⁴

IEC 60598-1:2014, *Luminaires – Part 1: General requirements and tests*

IEC 60598-1:2014/AMD1:2017⁵

IEC 60603-11, *Connectors for frequencies below 3 MHz for use with printed boards – Part 11: Detail specification for concentric connectors (dimensions for free connectors and fixed connectors)*

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

IEC 60664-3:2016, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of coating, potting or moulding for protection against pollution*

IEC 60664-4:2005, *Insulation coordination for equipment within low-voltage systems – Part 4: Consideration of high-frequency voltage stress*

IEC 60691, *Thermal-links – Requirements and application guide*

IEC 60695-1-10, *Fire hazard testing – Part 1-10: Guidance for assessing the fire hazard of electrotechnical products – General guidelines*

IEC 60695-2-11:2014, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

IEC 60695-2-12, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*

IEC 60695-2-13, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials*

IEC 60695-10-2:2014, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test method*

IEC 60695-11-5:2016, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60730-1:2013, *Automatic electrical controls – Part 1: General requirements*

IEC 60730-1:2013/AMD1:2015⁶

IEC 60730-2-6, *Automatic electrical controls – Part 2-6: Particular requirements for automatic electrical pressure sensing controls including mechanical requirements*

⁴ There exists a consolidated edition 2.2:2013 that includes edition 2 and its Amendment 1 and Amendment 2.

⁵ There exists a consolidated edition 8.1:2017 that includes edition 8 and its Amendment 1.

⁶ There exists a consolidated edition 5.1:2015 that includes edition 5 and its Amendment 1.

IEC 60730-2-8:2018, *Automatic electrical controls – Part 2-8: Particular requirements for electrically operated water valves, including mechanical requirements*

IEC 60730-2-9:2015, *Automatic electrical controls – Part 2-9: Particular requirements for temperature sensing controls*

IEC 60730-2-9:2015/AMD1:2018⁷

IEC 60730-2-10, *Automatic electrical controls for household and similar use – Part 2-10: Particular requirements for motor-starting relays*

IEC 60738-1, *Thermistors – Directly heated positive temperature coefficient – Part 1: Generic specification*

IEC 60799, *Electrical accessories – Cord sets and interconnection cord sets*

IEC 60906-1, *IEC system of plugs and socket-outlets for household and similar purposes – Part 1: Plugs and socket-outlets 16 A 250 V a.c.*

IEC 60934, *Circuit-breakers for equipment (CBE)*

IEC 60990:2016, *Methods of measurement of touch current and protective conductor current*

IEC 60999-1:1999, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm² up to 35 mm² (included)*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test*

IEC 61000-4-5, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement techniques – Surge immunity test*

IEC 61000-4-6, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

IEC 61000-4-11:2020, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current up to 16 A per phase*

IEC 61000-4-13:2002, *Electromagnetic compatibility (EMC) – Part 4-13: Testing and measurement techniques – Harmonics and interharmonics including mains signalling at a.c. power port, low frequency immunity tests*

IEC 61000-4-13:2002/AMD1:2009

IEC 61000-4-13:2002/AMD2:2015⁸

⁷ There exists a consolidated edition 4.1:2018 that includes edition 4 and its Amendment 1.

⁸ There exists a consolidated edition 1.2:2015 that includes edition 1 and its Amendment 1 and Amendment 2.

IEC 61000-4-34:2005, *Electromagnetic compatibility (EMC) – Part 4-34: Testing and measurement techniques – Voltage dips, short interruptions and voltage variations immunity tests for equipment with input current more than 16 A per phase*
IEC 61000-4-34:2005/AMD1:2009⁹

IEC 61032:1997, *Protection of persons and equipment by enclosures – Probes for verification*

IEC 61058-1:2016, *Switches for appliances – Part 1: General requirements*

IEC 61058-1-1:2016, *Switches for appliances – Part 1-1: Requirements for mechanical switches*

IEC 61058-1-2:2016, *Switches for appliances – Part 1-2: Requirements for electronic switches*

IEC 61180, *High-voltage test techniques for low-voltage equipment – Definitions, test and procedure requirements, test equipment*

IEC 61210, *Connecting devices – Flat quick-connect terminations for electrical copper conductors – Safety requirements*

IEC 61558-1:2017, *Safety of transformers, reactors, power supply units and combinations thereof – Part 1: General requirements and tests*

IEC 61558-2-6:2009, *Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V – Part 2-6: Particular requirements and tests for safety isolating transformers and power supply units incorporating safety isolating transformers*

IEC 61558-2-16:2009, *Safety of transformers, reactors, power supply units and similar products for supply voltages up to 1 100 V – Part 2-16: Particular requirements and tests for switch mode power supply units and transformers for switch mode power supply units*
IEC 61558-2-16:2009/AMD1:2013¹⁰

IEC 61770, *Electric appliances connected to the water mains – Avoidance of backsiphonage and failure of hose-sets*

IEC 62133-1:2017, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications – Part 1: Nickel systems*

IEC 62133-2:2017, *Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in portable applications – Part 2: Lithium systems*

IEC 62151, *Safety of equipment electrically connected to a telecommunication network*

IEC 62471:2006, *Photobiological safety of lamps and lamp systems*

IEC 62477-1, *Safety requirements for power electronic converter systems and equipment – Part 1: General*

IEC 62821 (all parts), *Electric cables – Halogen-free, low smoke, thermoplastic insulated and sheathed cables of rated voltages up to and including 450/750 V*

⁹ There exists a consolidated edition 1.1:2009 that includes edition 1 and its Amendment 1.

¹⁰ There exists a consolidated edition 1.1:2013 that includes edition 1 and its Amendment 1.

IEC TS 63542:2024, *Refrigerant detection systems for flammable refrigerants*

ISO 178, *Plastics – Determination of flexural properties*

ISO 179-1, *Plastics – Determination of Charpy impact properties – Part 1: Non-instrumented impact test*

ISO 180, *Plastics – Determination of Izod impact strength*

ISO 527 (all parts), *Plastics – Determination of tensile properties*

ISO 527-3, *Plastics – Determination of tensile properties – Part 3: Test conditions for films and sheets*

ISO 817, *Refrigerants – Designation and safety classification*

ISO 1302¹¹, *Geometrical Product Specifications (GPS) – Indication of surface texture in technical product documentation*

ISO 1463, *Metallic and oxide coatings – Measurement of coating thickness – Microscopical method*

ISO 2178, *Non-magnetic coatings on magnetic substrates – Measurement of coating thickness – Magnetic method*

ISO 2768-1, *General tolerances – Part 1: Tolerances for linear and angular dimensions without individual tolerance indications*

ISO 2578, *Plastics – Determination of time-temperature limits after prolonged exposure to heat*

ISO 4892-1:2016, *Plastics – Methods of exposure to laboratory light sources – Part 1: General guidance*

ISO 4892-2: 2013, *Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon-arc lamps*

ISO 5149-1:2014, *Refrigerating systems and heat pumps – Safety and environmental requirements – Part 1: Definitions, classification and selection criteria*

ISO 5149-1:2014/AMD1:2015

ISO 5149-1:2014/AMD2:2021

ISO 5149-2:2014, *Refrigerating systems and heat pumps – Safety and environmental requirements – Part 2: Design, construction, testing, marking and documentation*

ISO 5149-2:2014/AMD1:2020

ISO 5149-3:2014, *Refrigerating systems and heat pumps – Safety and environmental requirements – Part 3: Installation site*

ISO 5149-3:2014/AMD1:2021

ISO 5151, *Non-ducted air conditioners and heat pumps – Testing and rating for performance*

ISO 7000, *Graphical symbols for use on equipment – Registered symbols*

¹¹ Withdrawn.

ISO 7010:2019, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

ISO 8256, *Plastics – Determination of tensile-impact strength*

ISO 9772, *Cellular plastics – Determination of horizontal burning characteristics of small specimens subjected to a small flame*

ISO 9773, *Plastics – Determination of burning behaviour of thin flexible vertical specimens in contact with a small-flame ignition source*

ISO 13253, *Ducted air-conditioners and air-to-air heat pumps – Testing and rating for performance*

ISO 13256 (all parts), *Water-source heat pumps – Testing and rating for performance*

ISO 13355, *Packaging – Complete, filled transport packages and unit loads – Vertical random vibration test*

ISO 14903, *Refrigerating systems and heat pumps – Qualification of tightness of components and joints*

ISO 15042, *Multiple split-system air-conditioners and air-to-air heat pumps – Testing and rating for performance*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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>

When the terms "voltage" and "current" are used, they are RMS values, unless otherwise specified.

When the term "earthing" is used, it means "protective earthing", unless otherwise specified.

3.1 Definitions relating to physical characteristics

3.1.1 **rated voltage**

voltage assigned to the appliance by the manufacturer

3.1.2 **rated voltage range**

voltage range assigned to the appliance by the manufacturer, expressed by its lower and upper limits

3.1.3 **working voltage**

maximum voltage to which the part under consideration is subjected when the appliance is supplied at its **rated voltage** and operating under **normal operation**, with controls and switching devices positioned so as to maximize the value

Note 1 to entry: **Working voltage** takes into account resonant voltages.

Note 2 to entry: When deducing the **working voltage**, the effect of transient voltages is ignored.

3.1.4

rated power input

power input assigned to the appliance by the manufacturer

Note 1 to entry: If no power input is assigned to the appliance, the **rated power input** for **heating appliances** and **combined appliances** is the power input measured when the appliance is supplied at **rated voltage** and operated under **normal operation**.

Note 101 to entry: If the appliance comprises electrical accessories, including fans, the **rated power input** is based upon the total maximum **electrical power input** with all accessories energized, when operating continuously under the appropriate environmental conditions. If the **heat pump** can be operated in the heating or cooling mode, the **rated power input** is based upon the input in the heating or in the cooling mode, whichever is the greater.

3.1.5

rated power input range

power input range assigned to the appliance by the manufacturer, expressed by its lower and upper limits

3.1.6

rated current

current assigned to the appliance by the manufacturer

Note 1 to entry: If no current is assigned to the appliance, the **rated current** is the current measured when the appliance is supplied at **rated voltage** and operated under **normal operation**.

3.1.7

rated frequency

frequency assigned to the appliance by the manufacturer

3.1.8

rated frequency range

frequency range assigned to the appliance by the manufacturer, expressed by its lower and upper limits

3.1.9

normal operation

conditions under which the appliance is operated in normal use when it is connected to the supply mains

Appliances operated with **integral batteries** or **separable batteries** not disconnected from the appliance for charging purposes:

- the **battery** that is **fully discharged** is charged with the **battery-operated appliance** performing its intended function, if allowed by the construction of the appliance;
- the **battery** that is **fully discharged** is charged without the **battery-operated appliance** performing its intended function

Note 1 to entry: Operation of a **battery-operated appliance** to perform its intended function is considered to be **normal operation**.

3.1.10

rated impulse voltage

voltage derived from the **rated voltage** and the overvoltage category of the appliance, characterizing the specified withstand capability of its insulation against transient overvoltages

3.1.11

dangerous malfunction

unintended operation of the appliance that may impair safety

3.1.12

outlet load

load that can be connected to appliance outlets accessible to the user and socket-outlets accessible to the user

Note 1 to entry: Outlets with a voltage not exceeding **SELV** are not considered to be an appliance outlet.

3.2 Definitions relating to means of connection

3.2.1

supply leads

set of wires intended for connecting the appliance to fixed wiring and accommodated in a compartment within or attached to the appliance

3.2.2

interconnection cord

external flexible cord between two parts of an appliance, provided as part of a complete appliance for purposes other than connection to the supply mains

Note 1 to entry: In **battery-operated appliances**, if the **battery** is placed in a separate box, the flexible lead or flexible cord connecting the box with the appliance is considered to be an **interconnection cord**.

Note 2 to entry: The output cord from a **charging system** or a **detachable power supply part** is an **interconnection cord**.

3.2.3

supply cord

flexible cord, for supply purposes, that is fixed to the appliance

3.2.4

type X attachment

method of attachment of the **supply cord** such that it can easily be replaced

Note 1 to entry: The **supply cord** may be specially prepared and only available from the manufacturer or its service agent. A specially prepared cord may include a part of the appliance.

3.2.5

type Y attachment

method of attachment of the **supply cord** such that any replacement is intended to be made by the manufacturer, its service agent or similar qualified person

3.2.6

type Z attachment

method of attachment of the **supply cord** such that it cannot be replaced without breaking or destroying the appliance

3.3 Definitions relating to protection against electric shock

3.3.1

basic insulation

insulation applied to **live parts** to provide basic protection against electric shock

3.3.2

supplementary insulation

independent insulation applied in addition to **basic insulation**, in order to provide protection against electric shock in the event of a failure of **basic insulation**

3.3.3

double insulation

insulation system comprising both **basic insulation** and **supplementary insulation**

3.3.4**reinforced insulation**

single insulation applied to **live parts**, that provides a degree of protection against electric shock equivalent to **double insulation** under the conditions specified in this standard

Note 1 to entry: It is not implied that the insulation is one homogeneous piece. The insulation may comprise several layers which cannot be tested singly as **supplementary insulation** or **basic insulation**.

3.3.5**functional insulation**

insulation between conductive parts of different potential which is necessary only for the proper functioning of the appliance

3.3.6**protective impedance**

impedance connected between **live parts** and **accessible conductive parts** of **class II constructions** so that the current, in normal use and under likely fault conditions in the appliance, is limited to a safe value

3.3.7**class 0 appliance**

appliance in which protection against electric shock relies upon **basic insulation** only, there being no means for the connection of conductive **accessible parts**, if any, to the protective conductor in the fixed wiring of the installation, reliance in the event of a failure of the **basic insulation** being placed upon the environment

Note 1 to entry: **Class 0 appliances** have either an enclosure of insulating material which may form a part or the whole of the **basic insulation**, or a metal enclosure which is separated from **live parts** by an appropriate insulation. If an appliance with an enclosure of insulating material has provision for earthing internal parts, it is considered to be a **class I appliance** or **class 0I appliance**.

3.3.8**class 0I appliance**

appliance having at least **basic insulation** throughout and incorporating an earthing terminal but having a **supply cord** without earthing conductor and a plug without earthing contact

3.3.9**class I appliance**

appliance in which protection against electric shock does not rely on **basic insulation** only but which includes an additional safety precaution, in that conductive **accessible parts** are connected to the protective earthing conductor in the fixed wiring of the installation in such a way that conductive **accessible parts** cannot become live in the event of a failure of the **basic insulation**

Note 1 to entry: This provision includes a protective earthing conductor in the **supply cord**.

3.3.10**class II appliance**

appliance in which protection against electric shock does not rely on **basic insulation** only but in which additional safety precautions are provided, such as **double insulation** or **reinforced insulation**, there being no provision for protective earthing or reliance upon installation conditions

Note 1 to entry: Such an appliance may be of one of the following types:

- an appliance having a durable and substantially continuous enclosure of insulating material which envelops all metal parts, with the exception of parts, such as nameplates, screws and rivets, which are isolated from **live parts** by insulation at least equivalent to **reinforced insulation**; such an appliance is called an insulation-encased **class II appliance**;
- an appliance having a substantially continuous metal enclosure, in which **double insulation** or **reinforced insulation** is used throughout; such an appliance is called a metal-encased **class II appliance**;
- an appliance which is a combination of an insulation-encased **class II appliance** and a metal-encased **class II appliance**.

Note 2 to entry: The enclosure of an insulation-encased **class II appliance** may form a part or the whole of the **supplementary insulation** or of the **reinforced insulation**.

Note 3 to entry: **Class II appliances** may incorporate an earth for functional purposes.

3.3.11

class II construction

part of an appliance for which protection against electric shock relies upon **double insulation** or **reinforced insulation**

3.3.12

class III appliance

appliance in which protection against electric shock relies on supply at **safety extra-low voltage** and in which voltages higher than those of **safety extra-low voltage** are not generated

Note 1 to entry: **Basic insulation** may be required in addition to supply at **SELV**. Refer to 8.1.4.

Note 2 to entry: **Class III appliances** may incorporate an earth for functional purposes.

3.3.13

class III construction

part of an appliance for which protection against electric shock relies upon **safety extra-low voltage** and in which voltages higher than those of **safety extra-low voltage** are not generated

Note 1 to entry: **Basic insulation** may be required in addition to supply at **SELV**. Refer to 8.1.4.

3.3.14

clearance

shortest distance in air between two conductive parts or between a conductive part and the **accessible surface**

3.3.15

creepage distance

shortest distance along the surface of insulation between two conductive parts or between a conductive part and the **accessible surface**

3.4 Definitions relating to extra-low voltage

3.4.1

extra-low voltage

voltage supplied from a source within the appliance that does not exceed 50 V between conductors and between conductors and earth or functional earth when the appliance is supplied at **rated voltage**

3.4.2

safety extra-low voltage

voltage not exceeding 42 V between conductors and between conductors and earth or functional earth, the no-load voltage not exceeding 50 V

Note 1 to entry: When **safety extra-low voltage** is obtained from the supply mains, it is to be through a **safety isolating transformer** or a convertor with separate windings, the insulation of which complies with **double insulation** or **reinforced insulation** requirements.

Note 2 to entry: The voltage limits specified are based on the assumption that the **safety isolating transformer** is supplied at its **rated voltage**.

Note 3 to entry: **Safety extra-low voltage** is also known as **SELV**.

3.4.3

safety isolating transformer

transformer, the input winding of which is electrically separated from the output winding by an insulation at least equivalent to **double insulation** or **reinforced insulation**, that is intended to supply an appliance or circuit at **safety extra-low voltage**

3.4.4**protective extra-low voltage circuit**

earthed circuit operating at **extra-low voltage** that is separated from other circuits, except circuits operating at **safety extra-low voltage**, by **basic insulation** and protective screening, **double insulation** or **reinforced insulation**

Note 1 to entry: Protective screening is the separation of circuits from **live parts** by means of an earthed screen.

Note 2 to entry: A **protective extra-low voltage circuit** is also known as a **PELV circuit**.

3.5 Definitions relating to types of appliances**3.5.1****portable appliance**

appliance that is intended to be moved while in operation or an appliance, other than a **fixed appliance**, having a mass less than 18 kg

3.5.2**hand-held appliance**

portable appliance intended to be held in the hand during normal use

3.5.3**stationary appliance**

fixed appliance or an appliance which is not a **portable appliance**

3.5.4**fixed appliance**

appliance that is intended to be used while fastened to a support or while secured in a specific location

Note 101 to entry: Appliances connected to water pipes or refrigerant pipes that are secured to the building are also **fixed appliances**.

3.5.5**built-in appliance**

fixed appliance intended to be installed in a cabinet, in a prepared recess in a wall or in a similar location

3.5.6**heating appliance**

appliance incorporating heating elements but without any motor

3.5.7**motor-operated appliance**

appliance incorporating motors but without any heating element

Note 1 to entry: Magnetically driven appliances are considered to be **motor-operated appliances**.

3.5.8**combined appliance**

appliance incorporating heating elements and motors

3.5.9**battery-operated appliance**

appliance deriving its energy from **batteries** enabling the appliance to perform its intended function without a supply connection

Note 1 to entry: A **battery-operated appliance** can have a supply connection.

3.6 Definitions relating to parts of an appliance

3.6.1

non-detachable part

part that can only be removed or opened with the aid of a **tool** or part that fulfils the test of 22.11

3.6.2

detachable part

part that can be removed or opened without the aid of a **tool**, part that is removed or opened in accordance with the instructions for use, even if a **tool** is needed for removal, or part that does not fulfil the test of 22.11

Note 1 to entry: If for installation purposes a part has to be removed, this part is not considered to be a **detachable part** even if the instructions state that it is to be removed.

Note 2 to entry: Components that can be removed without the aid of a **tool** are considered to be **detachable parts**.

Note 3 to entry: If a part has to be removed solely to discard a **battery** before scrapping the appliance, this part is not considered to be a **detachable part** even if the instructions state that it is to be removed.

3.6.3

accessible part

part or surface that can be touched by means of test probe B of IEC 61032, and if the part or surface is metal, any conductive part connected to it

Note 1 to entry: **Accessible non-metallic parts** with conductive coatings are considered to be **accessible metal parts**.

3.6.4

live part

conductor or conductive part intended to be energized in normal use, including a neutral conductor but, by convention, not a PEN conductor

Note 1 to entry: Parts, accessible or not, complying with 8.1.4 are not considered to be **live parts**.

Note 2 to entry: A PEN conductor is a protective earthed neutral conductor combining the functions of both a protective conductor and a neutral conductor.

Note 3 to entry: Parts, whether they are **accessible parts** or not, of **battery-operated appliances** and **batteries** not exceeding the electrical limits of B.22.3 and B.22.4, are not considered to be **live parts**.

3.6.5

tool

screwdriver, coin, or any other object that may be used to operate a screw or similar fixing means

3.6.6

small part

part, where each surface lies completely within a circle of 15 mm diameter, or part where some of the surface lies outside a 15 mm diameter circle but in such a way that it is not possible to fit a circle of 8 mm diameter on any of the surfaces

Note 1 to entry: A part that is too small to grip and at the same time to be able to apply the glow-wire tip is shown in example A in Figure 5. A part that is large enough to grip but that is too small to be able to apply the glow-wire tip is shown in example B in Figure 5. A part that is not a **small part** is shown in example C in Figure 5.

3.6.7

detachable power supply part

part of the appliance the output of which is intended to be detachable from the **class III construction** part of the appliance

Note 1 to entry: Means of detachment are a flexible cord and connector or an appliance outlet fitted to the **detachable power supply part**.

3.6.8**cell**

basic functional unit, consisting of an assembly of electrodes, electrolyte, container, terminals, and usually separators that is a source of electric energy obtained by direct conversion of chemical energy

[SOURCE: IEC 60050-482:2004, 482-01-01]

3.6.9**battery**

assembly of one or more **cells** ready for use as a source of electrical energy, characterised by its voltage, size, terminal arrangement, capacity and rate capability

Note 1 to entry: A **detachable battery** and **separable battery** have an enclosure that is equivalent in properties to that of the appliance itself, but **integral batteries** may have no enclosure or an enclosure less substantial than that of the appliance, as they are protected by the enclosure of the appliance.

3.6.10**detachable battery**

rechargeable **battery** in an enclosure separate from the **battery-operated appliance**, intended for use with specific appliances and intended to be removed from the appliance for charging purposes

Note 1 to entry: A standard automotive **battery** is not considered a **detachable battery**.

Note 2 to entry: A **detachable battery** is not considered a **battery** that is replaceable.

3.6.11**separable battery**

battery contained in an enclosure separate from the **battery-operated appliance**, intended for use with specific appliances and connected to the appliance by a cord external to the enclosure of the appliance

Note 1 to entry: A standard automotive **battery** is not considered a **separable battery**.

Note 2 to entry: A **separable battery** is not considered a **battery** that is replaceable.

3.6.12**integral battery**

battery contained within the **battery-operated appliance** and not removed from the appliance for charging purposes

Note 1 to entry: A **battery** that is only to be removed from the **battery-operated appliance** for disposal or recycling is still considered to be an **integral battery**.

3.7 Definitions relating to safety components**3.7.1****thermostat**

temperature-sensing device, the operating temperature of which may be either fixed or adjustable and which during **normal operation** keeps the temperature of the controlled part between certain limits by automatically opening and closing a circuit

3.7.2**temperature limiter**

temperature-sensing device, the operating temperature of which may be either fixed or adjustable and which during **normal operation** operates by opening or closing a circuit when the temperature of the controlled part reaches a pre-determined value

Note 1 to entry: A **temperature limiter** does not make the reverse operation during the normal duty cycle of the appliance. It may or may not require manual resetting.

3.7.3

thermal cut-out

device which during abnormal operation limits the temperature of the controlled part by automatically opening the circuit, or by reducing the current, and is constructed so that its setting cannot be altered by the user

3.7.4

self-resetting thermal cut-out

thermal cut-out that automatically restores the current after the relevant part of the appliance has cooled down sufficiently

3.7.5

non-self-resetting thermal cut-out

thermal cut-out that requires a manual operation for resetting, or replacement of a part, in order to restore the current

Note 1 to entry: Manual operation includes disconnection of the appliance from the supply mains.

3.7.6

protective device

device, the operation of which prevents a hazardous situation under abnormal operation conditions

3.7.7

thermal link

thermal cut-out which operates only once and requires partial or complete replacement

3.7.8

intentionally weak part

part intended to rupture under conditions of abnormal operation to prevent the occurrence of a condition which could impair compliance with this standard

Note 1 to entry: Such a part may be a replaceable component, such as a resistor or a capacitor, or a part of a component to be replaced, such as a **thermal link** that is not an **accessible part** incorporated in a motor.

3.8 Definitions relating to miscellaneous matters

3.8.1

all-pole disconnection

disconnection of both supply conductors by a single initiating action or, for multi-phase appliances, disconnection of all supply conductors by a single initiating action

Note 1 to entry: For multi-phase appliances, the neutral conductor is not considered to be a supply conductor.

3.8.2

off position

stable position of a switching device in which the circuit controlled by the switch is disconnected from its supply or, for electronic disconnection, the circuit is de-energized

Note 1 to entry: The **off position** does not imply an **all-pole disconnection**.

3.8.3

visibly glowing heating element

heating element that is partly or completely visible from the outside of the appliance and has a temperature of at least 650 °C when the appliance has been operated under **normal operation** at **rated power input** until steady conditions have been established

3.8.4**PTC heating element**

element intended for heating consisting mainly of positive temperature coefficient resistors that are thermally sensitive and have a rapid non-linear increase in resistance when the temperature is raised through a particular range

3.8.5**user maintenance**

any maintenance operation stated in the instructions for use, or marked on the appliance, that the user is intended to perform

3.8.6**room temperature**

ambient temperature specified in the general conditions for the tests

Note 1 to entry: The ambient temperature is specified in 5.7.

3.8.101**particle foam material**

closed cell material moulded from thermoplastic particles (e.g. beads) with expanding agent

3.9 Definitions relating to electronic circuits**3.9.1****electronic component**

part in which conduction is achieved principally by electrons moving through a vacuum, gas or semiconductor

Note 1 to entry: Neon indicators are not considered to be **electronic components**.

3.9.2**electronic circuit**

circuit incorporating at least one **electronic component**

3.9.3**protective electronic circuit**

electronic circuit that prevents a hazardous situation under abnormal operating conditions

Note 1 to entry: Parts of the circuit may also be used for functional purposes.

3.10 Definitions relating to battery charging and discharging**3.10.1****battery system**

system that includes a **battery**, **charging system** and the **battery-operated appliance**

Note 1 to entry: The **battery system**, including interfaces, may contain more than one **battery** and **charging system**.

3.10.2**charging system**

circuitry that charges and maintains the state of charge of the **battery**

Note 1 to entry: Parts of the **charging system** may perform other functions such as charge balancing and may be separately enclosed.

3.10.3**specified operating region for charging**

region during charging in which a **cell** operates within its voltage and current range as specified by the **cell** manufacturer

Note 1 to entry: An example of a specified operating region of a lithium-ion **cell** during charging is shown in Figure 14.

3.10.4

upper limit charging voltage

highest charging voltage in the **specified operating region for charging**

3.10.5

venting

condition intended by design that occurs when a **cell** provides a controlled release of excessive internal pressure without expulsion of major components of the **cell**

3.10.6

fully charged

at the maximum state of charge

Note 1 to entry: For **cells** and **batteries** that are rechargeable, this is the maximum state of charge permitted by the **charging system**.

Note 2 to entry: The maximum state of charge for **non-rechargeable batteries** and **batteries** that are rechargeable is specified in the artificial source characteristics of Table B.1.

3.10.7

fully discharged

discharged at a steady rate of current to attain, at 5 h of steady discharge (C_5 rate), or the fastest discharge rate allowed by the **cell** manufacturer or **battery** manufacturer if it is slower than the C_5 rate, until

- discharge terminates due to operation of discharge termination circuitry; or
- the **battery** (or **cell**) reaches a total voltage with an average voltage per **cell** equal to the end-of-discharge voltage for the **cell** chemistry being used, unless a different end of discharge voltage is specified by the **cell** manufacturer

Note 1 to entry: Examples of the end-of-discharge voltages for **fully discharged** common **cell** chemistries are typically

- 0,9 V/**cell** for nickel cadmium;
- 0,9 V/**cell** for nickel metal-hydride;
- 1,75 V/**cell** for lead-acid;
- 2,5 V/**cell** for lithium iron-phosphate;
- 3,0 V/**cell** for lithium cobalt-oxide.

3.11 Definitions relating to remote functionality

3.11.1

entity

person, device, appliance, product, or service that interacts with an appliance

3.11.2

message

data which is transmitted from a sender (data source) to one or more receivers (data sink)

3.11.3

public network

network carrying digital data or analogue signals or both where access to the data and signals is not restricted by the physical space within the household or similar use environment of the appliance

Note 1 to entry: Determination of confinement to the physical space includes consideration of the network's range of communication, configuration, or construction.

For the purposes of this standard, examples of **public networks** include but are not limited to:

- PAN (personal area network);
- LAN (local area network) connected devices which may or may not be connected to a gateway,
- PLC (power line communication);
- SRD (short range devices);
- WAN (wide area network);

For the purposes of this standard, examples of networks which are not considered as being **public networks** include but are not limited to:

- NFC (near field communication);
- optical communication with line of sight (infra-red rays or visual rays);
- hardwired configurations constructed of physical media;

without connection to a **public network**.

3.11.4

remote communication

transmission of data between the appliance and an **entity** that can be initiated out of sight of the appliance, using communication means such as radio wave modulation, sound wave modulation or bus systems

Note 1 to entry: Examples of transmission of data includes but are not limited to remote monitoring, software downloading or control parameter modifications.

Note 2 to entry: Transmission of data can be one-way (simplex) or two-way (duplex).

3.11.5

remote operation

control of an appliance by **remote communication**

Note 1 to entry: **Remote communication** that results in a change of appliance operation, such as change of rotational speed, temperature, spatial movement, start/stop of the intended function, is considered **remote operation**. It is possible to have **remote communication** that does not lead to **remote operation**.

Note 2 to entry: A line of sight infra-red signal by itself is not considered one used for **remote operation**.

3.101

heat pump

appliance which takes up heat at a certain temperature and releases heat at a higher temperature

Note 1 to entry: When operated to provide heat (e.g., for space heating or water heating), the appliance is said to operate in the heating mode; when operated to remove heat (for example, for space cooling), it is said to operate in the cooling mode.

Note 2 to entry: A **heat pump** can contain a combination of **condensing unit or condenser unit** and an **evaporating unit or evaporator unit** and can be equipped to operate in a reverse cycle mode.

3.102

sanitary hot water heat pump

heat pump intended to transfer heat to water suitable for human consumption

3.103

air-conditioner

encased assembly or assemblies designed as an appliance to provide delivery of conditioned air to an enclosed space, room or zone

Note 1 to entry: It includes an electrically operated **refrigerating system** for cooling and possibly dehumidifying the air.

Note 2 to entry: It can have means for heating, circulating, cleaning and humidifying the air.

Note 3 to entry: An **air-conditioner** can contain a combination of **condensing unit or condenser unit** and an **evaporating unit or evaporator unit**.

3.104**dehumidifier**

encased assembly designed to remove moisture from its surrounding atmosphere

Note 1 to entry: It includes an electrically operated **refrigerating system** and the means to circulate air. It also includes a drain arrangement for collecting and storing and/or disposing of the condensate.

3.108**wet-bulb temperature****WB**

temperature indicated when the temperature-sensitive element in a wetted wick has reached a state of constant temperature (evaporative equilibrium)

3.109**dry-bulb temperature****DB**

temperature indicated by a dry, temperature-sensitive element shielded from the effects of radiation

3.110**evaporator**

heat exchanger in which refrigerant liquid is vaporized by absorption of heat

3.111**heat exchanger**

device specifically designed to transfer heat between two physically separated fluids (gas or liquid)

3.112**indoor heat exchanger**

heat exchanger designed to transfer heat to the indoor parts of the building or to the indoor hot water supplies (e.g. sanitary water) or to remove heat therefrom

3.113**outdoor heat exchanger**

heat exchanger designed to remove or release heat from the heat source (for example, ground water, outdoor air, exhaust air, water or brine)

3.114 Supplementary heaters**3.114.1****supplementary heater**

electric heater that supplements or replaces the output of the refrigerant circuit for the purpose of heating air or water

3.114.2**supplementary water heater**

supplementary heater specifically for the purpose of heating water

3.114.3**supplementary air heater**

supplementary heater specifically for the purpose of heating air in conjunction with, or instead of, the refrigerating circuit

Note 1 to entry: **Supplementary air heaters** include electric heaters provided as part of an appliance with cooling-only refrigerant circuits.

3.115**pressure-limiting device**

mechanism that automatically responds to a predetermined pressure by stopping the operation of the pressure-imposing element

3.116**pressure-relief device**

pressure actuated valve or rupture member which functions to relieve excessive pressure automatically

3.117**appliances accessible to the general public**

appliances intended to be located in residential buildings or in commercial buildings in a location without restricted access

3.118**appliances not accessible to the general public**

appliances which are located in a secured location with restricted access (e.g. machine rooms, rooftop and the like, or at a level above 2,5 m)

3.119**hydronic fan coil unit**

factory-made assembly which provides the function of forced circulation of air for heating and/or cooling, which can also include the function of **dehumidification** and/or filtering of air, but which does not include the source of cooling or heating

Note 1 to entry: **Hydronic fan coil units** can include provision for electric resistance heating. **Heat exchanger** coils are intended for hydronic heating and cooling only.

3.120**flammable refrigerant**

refrigerant classified as safety group A2L, A2 or A3 according to ISO 817

3.121**refrigerating system**

combination of interconnected refrigerant containing parts constituting one closed refrigerant circuit in which the refrigerant is circulated for the purpose of extracting heat at the low temperature side to reject heat at the high temperature side by changing the state of the refrigerant

3.122**maximum allowable pressure**

maximum pressure for which the equipment is designed, as specified by the manufacturer

Note 1 to entry: **Maximum allowable pressure** constitutes a limit to the operating pressure of a **refrigerating system**, hydronic circuit or sanitary hot water tank whether the equipment is working or not, see Clause 21.

3.123**low-pressure side**

part(s) of a **refrigerating system** operating at the **evaporator** pressure

3.124**high-pressure side**

part(s) of a **refrigerating system** operating at the **condenser** pressure

3.125**service port**

means to access the refrigerant in a **refrigerating system** for the purpose of charging or servicing the system, typically a valve, tube extension or entry location

3.126

factory sealed single package unit

factory assembly of components of **refrigerating system** fixed on a common mounting to form a discrete unit in which all **refrigerating system** parts have been sealed tight by welding, brazing or a similar permanent connection during the manufacturing process

3.127

pre-charged pipe sets

interconnecting refrigerant lines which are supplied with the unit and supplied with a **refrigerant charge** for the purpose of completing the **refrigerating system** in the field for appliances that are made up of more than one subassembly and are assembled in the field to complete the **refrigerating system**

3.128

condenser

heat exchanger in which refrigerant vapour is condensed by removal of heat

3.129

condensing unit

factory-made assembly that includes one or more motor-compressors, **condenser** in cooling mode and motor-driven fan, blower or pump to circulate the heat transfer fluid through the **condenser** with associated operational controls in addition to the necessary wiring

Note 1 to entry: These units are intended for field connection to an **evaporator unit**. A **condensing unit** can also be equipped to operate in the reverse cycle mode. A **condensing unit** can include expansion device(s).

3.130

condenser unit

factory-made assembly that includes one or more **condensers** in cooling mode and motor-driven fan, blower or pump to circulate the heat transfer fluid through the **condenser** with associated operational controls in addition to the necessary wiring

Note 1 to entry: These units are intended for field connection to an **evaporating unit**. A **condenser unit** can also be equipped to operate in the reverse cycle mode.

Note 2 to entry: A **condenser unit** does not include a motor-compressor or expansion device.

3.131

evaporating unit

factory-made assembly that includes one or more motor-compressors, **evaporator** in cooling mode, expansion device(s), and motor-driven fan, blower or pump to circulate fluid through the **evaporator** with associated operational controls in addition to the necessary wiring

Note 1 to entry: These units are intended for field connection to a **condenser unit**. An **evaporating unit** can also be equipped to operate in the reverse cycle mode and can include provision for electric resistance heating or similar sources of auxiliary heat.

3.132

evaporator unit

factory-made assembly that includes one or more **evaporators** in cooling mode, and can include a motor-driven fan, blower or pump to circulate fluid through the **evaporator** with associated operational controls in addition to the necessary wiring

Note 1 to entry: These units are intended for field connection to a **condensing unit**. An **evaporator unit** can also be equipped to operate in the reverse cycle mode and can include provision for electric resistance heating or similar sources of auxiliary heat. An **evaporator unit** can include expansion device(s).

Note 2 to entry: An **evaporator unit** does not include a motor-compressor.

3.133**partial unit**

condensing unit, evaporating unit, condenser unit, or evaporator unit which are part of a total assembly of a **heat pump, air-conditioner, or sanitary hot water heat pumps** where not all assemblies to create the complete **refrigerating system** are specified by the manufacturer

Note 1 to entry: **Partial units** are evaluated for safety as stand-alone.

3.134**installed height**
 h_{inst}

height of the bottom of the appliance relative to the floor of the room after installation

Note 1 to entry: The **installed height** is given in metres.

3.135**release offset**
 h_{rel}

distance from the bottom of the appliance to an opening where the refrigerant can leave the appliance in the event of a refrigerant leak

Note 1 to entry: The **release offset** is given in metres.

3.136**refrigerant charge**
 m_c

actual **refrigerant charge** of a single **refrigerating system**

Note 1 to entry: The **refrigerant charge** is expressed in kg.

3.137**maximum refrigerant charge**
 m_{max}

maximum refrigerant charge for a single **refrigerating system** as result from a calculation for room area or similar

Note 1 to entry: The **maximum refrigerant charge** is expressed in kg.

3.138**refrigerant detection system**

sensing system which gives an output signal in response to a pre-set concentration of refrigerant in the environment

Note 1 to entry: A **refrigerant detection system** can have multiple **refrigerant sensors**.

3.139**auto ignition temperature**

AIT

lowest temperature at or above which a chemical can spontaneously ignite in a normal atmosphere, without an external source of ignition, such as a flame or spark

[SOURCE: ISO 5149-1:2014, 3.7.7, modified – the abbreviated term "AIT" has been added and "of a substance" has been deleted].]

3.140**hot surface ignition temperature**

highest temperature at which a refrigerant does not ignite when tested in accordance with Annex KK

3.141**A2L refrigerant**

refrigerant classified as safety group A2L according to ISO 817

3.142**lower flammability limit****LFL**

minimum concentration of the refrigerant that is capable of propagating a flame through a homogeneous mixture of the refrigerant and air

Note 1 to entry: Data is listed in Annex BB.

[SOURCE: ISO 817:2014, 3.1.24, modified – "under the specified test conditions at 23,0 °C and 101,3 kPa" and Notes to entry deleted.]

3.143**enhanced tightness refrigerating system**

refrigerating system in which the indoor units are designed and fabricated to ensure a high level of confidence that large refrigerant leak rates will not occur in **normal operation** and abnormal operation

3.144**refrigerant distribution assembly**

separate refrigerant assembly which is installed in the interconnecting refrigerant lines for the purpose of distributing refrigerant flow to one or more indoor units

3.145**Void****3.146****circulation airflow**

mechanically induced airflow movement within the space or duct-connected spaces

3.147**Void****3.148****Void****3.149****Void****3.150****UV-C lamp**

source made to produce ultraviolet radiation in the range of 100 nm to 280 nm wavelengths

Note 1 to entry: There are several types of such lamps used for photobiological, photochemical and biomedical purposes.

3.151**Void****3.152****UV-C germicidal lamp system**

auxiliary device which utilizes **UV-C lamps** that directly generate germicidal radiation

Note 1 to entry: **UV-C germicidal lamp systems** are typically used to supplement the normal unit air filters for enhanced air purification and surface cleaning of the evaporator coil and surrounding area.

3.153**UV-C spectral irradiance**

measured electromagnetic radiation power density at a particular wavelength of 254 nm at a specified distance

Note 1 to entry: The spectral irradiance E_{254} is measured in $\mu\text{W}/\text{cm}^2$.

3.154

UV-C barrier

additional guard or shield that prevents UV-C light from exiting the unit or damaging internal non-metallic materials

3.155

transcritical refrigerating system

refrigerating system where evaporation occurs below the critical point and heat rejection can occur above the critical point of the refrigerant (e.g. R744)

3.156

releasable charge

m_{rl}

mass of refrigerant that can be released into the indoor space from a **refrigerating system** in the event of a leak

Note 1 to entry: Any part of the **refrigerant charge** that leaks to the outdoor is excluded from the **releasable charge**.

3.157

operating state

function that the appliance is in at a specific time during **normal operation**

Note 1 to entry: Examples include standby, cooling mode, heating mode and defrosting.

3.158

releasable charge limited system

refrigerating system in which the **releasable charge** is limited by design measures

EXAMPLE 1 Systems relying on closing **safety shut-off valves** when the compressor is off are examples of **releasable charge limited systems** not relying on **leak detection systems**.

EXAMPLE 2 Systems relying on measuring temperature, pressure, ultrasonic leak detection, or other working parameters to detect a leak are examples of **releasable charge limited systems** not relying on **refrigerant detection systems**.

3.159

safety shut-off valve

valve for the purpose of limiting the amount of **releasable charge**

3.160

leak detection system

sensing system which responds to refrigerant leaking from a **refrigerating system**

EXAMPLE A **refrigerant detection system** is an example of a **leak detection system**.

Note 1 to entry: A **leak detection system** can include gas sensing, ultrasonic or other such methods demonstrated to be sufficiently effective.

3.161

potential leak point

any point in the **refrigerating system** that can be a weak point due to manufacturing processes, exposure to damage, sharpness of a bend, or similar stresses

EXAMPLE **Potential leak points** can include parts under stress or vibration.

3.162

pressure vessel

any refrigerant-containing part of a refrigerating system other than

– compressors,

- pumps,
- component parts of sealed absorption systems,
- evaporators, each separate section of which does not exceed 15 l of refrigerant-containing volume,
- coils,
- piping and its valves, joints, and fittings,
- control devices, and
- pressure-containing components (including headers) having an internal diameter or largest cross-sectional dimension not greater than 152 mm

[SOURCE: ISO 5149-1:2014, 3.4.7]

3.163

refrigerant sensor

assembly in which the sensing element is housed and that can also contain associated circuit components

[SOURCE: IEC 60079-29-1:2016, 3.3.2, modified – "sensor" replaced by "refrigerant sensor".]

3.164

limited life refrigerant sensor

refrigerant sensor which is expected to fail within the life of the appliance

3.165

thermoelectric heat pump

solid-state **heat pump**, activated by an electric current, which takes up heat at a certain temperature and releases heat at a higher temperature

Note 1 to entry: A Peltier element is an example of such technology.

3.166

double wall heat exchanger

heat exchanger with two walls between the refrigerant and a secondary fluid

Note 1 to entry: **Double wall heat exchangers** avoid ingress of refrigerant into the secondary circuit or secondary fluid into the refrigeration circuit in case of leakage in one separating wall.

4 General requirement

Appliances shall be constructed so that in normal use, they function safely so as to cause no danger to persons or surroundings, even in the event of carelessness that may occur in normal use.

In general, this principle is achieved by fulfilling the relevant requirements specified in this standard and compliance is checked by carrying out all the relevant tests.

5 General conditions for the tests

Unless otherwise specified, the tests are carried out in accordance with this clause.

5.1 Tests according to this standard are type tests.

NOTE Routine tests are described in informative Annex A.

5.2 The tests are carried out on a single appliance that shall withstand all the relevant tests. However, the tests of Clauses 12, 20, 22 (except 22.10, 22.11 and 22.18) to 26, 28, 30 and 31 may be carried out on separate appliances. The test of 22.3 is carried out on a new appliance.

If an **intentionally weak part** becomes open circuit during the tests of Clause 19, an additional appliance may be needed.

The testing of components may require the submission of additional samples of these components.

If the test of normative Annex C has to be carried out, six samples of the motor are needed.

If the test of normative Annex D has to be carried out, an additional appliance may be used.

If the tests of normative Annex G are carried out, four additional transformers are needed.

If the tests of normative Annex H are carried out, three switches or three additional appliances are needed.

NOTE Additional samples can be required if the appliance has to be tested under different conditions, for example if it can be supplied with different voltages.

The cumulative stress resulting from successive tests on **electronic circuits** shall be avoided. It may be necessary to replace components or to use additional samples. The number of additional samples shall be kept to a minimum by an evaluation of the relevant **electronic circuits**.

If an appliance has to be dismantled in order to carry out a test, care shall be taken to ensure that it is reassembled as originally supplied. In case of doubt, subsequent tests may be carried out on a separate sample.

The testing of Clause 21 may be carried out on separate samples. The testing of Clause 11, Clause 19 and Clause 21 shall require that pressure measurements be made at various points in the **refrigerating system**.

NOTE 101 For reference purposes, the temperatures on the refrigerant piping can be measured during the test of Clause 11.

If the tests of Annex FF (leak simulation tests) and Annex QQ (methods for determining **releasable charge**) are carried out, at least one additional specially prepared sample is required.

If the test of Annex NN has to be carried out, an additional appliance may be used.

Tests of Clause 15 may be conducted on a separate sample. The test of 19.104.2 through 19.104.8 may be run in any sequence within Clause 19.

5.3 The tests are carried out in the order of the clauses. However, the test of 22.11 on the appliance at **room temperature** is carried out before the tests of Clause 8. The tests of Clause 14, 21.2 and 22.24 are carried out after the tests of Clause 29. The test of 19.14 is carried out before the tests of 19.11.

If it is evident from the construction of the appliance that a particular test is not applicable, the test is not carried out.

5.4 When testing appliances that are also supplied by other energies such as gas, the influence of their consumption has to be taken into account.

5.5 The tests are carried out with the appliance or any movable part of it placed in the most unfavourable position that may occur in normal use.

5.6 Appliances provided with controls or switching devices are tested with these controls or devices adjusted to their most unfavourable setting, if the setting can be altered by the user.

If the adjusting means of the control is accessible without the aid of a **tool**, this subclause applies whether the setting can be altered by hand or with the aid of a **tool**. If the adjusting means is not accessible without the aid of a **tool** and if the setting is not intended to be altered by the user, this subclause does not apply.

NOTE Adequate sealing is regarded as preventing alteration of the setting by the user.

For appliances fitted with a voltage selector switch, the tests are carried out with the switch in the position corresponding to the **rated voltage** value used for the tests.

Any controls which regulate the temperature or humidity of the conditioned space are rendered inoperative during the test.

5.7 The tests are carried out in a draught-free location at an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$.

If the temperature attained by any part is limited by a temperature sensitive device or is influenced by the temperature at which a change of state occurs, for example when water boils, the ambient temperature is maintained at $23\text{ °C} \pm 2\text{ °C}$ in case of doubt.

The tests and test conditions of Clause 10 and Clause 11 are carried out under the most severe operating conditions within the operating temperature range specified by the manufacturer. Annex AA provides examples of such temperature conditions.

5.8 Test conditions relating to frequency and voltage

5.8.1 Appliances for alternating current (AC) only are tested with AC at **rated frequency**, and those for AC and DC are tested at the more unfavourable supply.

Appliances for AC that are not marked with **rated frequency** or are marked with a **rated frequency range** of 50 Hz to 60 Hz are tested with either 50 Hz or 60 Hz, whichever is the more unfavourable.

5.8.2 Appliances having more than one **rated voltage** are tested on the basis of the most unfavourable voltage.

For **motor-operated appliances**, and **combined appliances**, marked with a **rated voltage range**, when it is specified that the supply voltage is equal to the **rated voltage** multiplied by a factor, the appliance is supplied at

- the upper limit of the **rated voltage range** multiplied by this factor, if greater than 1;
- the lower limit of the **rated voltage range** multiplied by this factor, if smaller than 1.

When a factor is not specified, the supply voltage is the most unfavourable within the **rated voltage range**.

If a **heating appliance** has a **rated voltage range**, the upper limit of the voltage range will usually be the most unfavourable voltage within the range. For **motor-operated appliances**, **combined appliances** and appliances having more than one **rated voltage** or **rated voltage range**, it may be necessary to make some of the tests at the minimum, the mean and the maximum values of the **rated voltage** or the **rated voltage range** in order to establish the most unfavourable voltage.

5.8.3 For **heating appliances**, and **combined appliances**, marked with a **rated power input range**, when it is specified that the power input is equal to the **rated power input** multiplied by a factor, the appliance is operated at

- the upper limit of the **rated power input range** multiplied by this factor, if greater than 1;
- the lower limit of the **rated power input range** multiplied by this factor, if smaller than 1.

When a factor is not specified, the power input is the most unfavourable within the **rated power input range**.

5.8.4 For appliances marked with a **rated voltage range** and **rated power input** corresponding to the mean of the **rated voltage range**, when it is specified that the power input is equal to **rated power input** multiplied by a factor, the appliance is operated at:

- the calculated power input corresponding to the upper limit of the **rated voltage range** multiplied by this factor, if greater than 1;
- the calculated power input corresponding to the lower limit of the **rated voltage range** multiplied by this factor, if smaller than 1.

When a factor is not specified, the power input corresponds to the power input at the most unfavourable voltage within the **rated voltage range**.

5.9 When alternative heating elements or accessories are made available by the appliance manufacturer, the appliance is tested with those elements or accessories which give the most unfavourable results.

5.10 The tests are carried out on the appliance as supplied. However, an appliance constructed as a single appliance but supplied in a number of units is tested after assembly in accordance with the instructions provided with the appliance.

A **class III construction** part of the appliance is tested connected to its **detachable power supply part** taking into account the instructions provided with the appliance.

Built-in appliances and **fixed appliances** are installed in accordance with the instructions provided with the appliance before testing.

If **batteries** intended for use with the appliance use metal-ion chemistry, the manufacturer or responsible agent shall provide the following information for each type of **battery**

- end-of-discharge voltage;
- **upper limit charging voltage**, for **batteries** comprising series connected **cells**;
- rated capacity of the **battery** (C_5 Ah).

If **cells** intended for use with the appliance use metal-ion chemistry, the manufacturer or responsible agent shall provide the **specified operating region for charging** for each type of **cell**.

For split units, the refrigerant lines shall be installed in accordance with the installation instructions. The length of the pipe shall be between 5 m and 7,5 m. Where the installation instructions specify a maximum pipe length of less than 5 m, the length of pipe shall be the maximum length specified in the installation instructions, and where the installation instructions specify a minimum pipe length of more than 7,5 m, the length of pipe shall be the minimum length specified in the installation instructions. The thermal insulation of the refrigerant lines shall be applied in accordance with the installation instructions.

5.11 Appliances intended to be connected to fixed wiring by means of a flexible cord are tested with the appropriate flexible cord connected to the appliance.

5.12 For **heating appliances** and **combined appliances**, when it is specified that the appliance has to operate at a power input multiplied by a factor, this applies only to heating elements without appreciable positive temperature coefficient of resistance.

For heating elements with appreciable positive temperature coefficient of resistance, other than **PTC heating elements**, the supply voltage is determined by supplying the appliance at **rated voltage** until the heating element reaches its operating temperature. The supply voltage is then rapidly increased to the value necessary to give the power input required for the relevant test, this value of the supply voltage being maintained throughout the test.

NOTE In general, the temperature coefficient is considered to be appreciable if, at **rated voltage**, the power input of the appliance in cold condition differs by more than 25 % from the power input at operating temperature.

5.13 The tests for appliances with **PTC heating elements** and for **heating appliances** and **combined appliances** where the heating elements are supplied via a switch mode power supply are carried out at a voltage corresponding to the specified power input.

When a power input greater than the **rated power input** is specified, the factor for multiplying the voltage is equal to the square root of the factor for multiplying the power input.

5.14 If **class 0I appliances** or **class I appliances** have **accessible metal parts** that are not earthed and are not separated from **live parts** by an intermediate metal part that is earthed, such parts are checked for compliance with the appropriate requirements specified for **class II construction**.

If **class 0I appliances** or **class I appliances** have **accessible non-metallic parts**, such parts are checked for compliance with the appropriate requirements specified for **class II construction** unless these parts are separated from **live parts** by an intermediate metal part that is earthed.

NOTE Guidance is given in informative Annex P for enhanced requirements that can be used to ensure an acceptable level of protection against electrical and thermal hazards for particular types of appliances used in an installation without a protective earthing conductor in countries that have tropical climates.

5.15 If appliances have parts operating at **safety extra-low voltage**, such parts are checked for compliance with the appropriate requirements specified for **class III construction**.

5.16 When testing **electronic circuits**, the supply is to be free from perturbations from external sources that can influence the results of the tests.

5.17 **Battery-operated appliances** and remote controls containing **batteries** are tested in accordance with normative Annex B.

Battery-operated appliances having a functional earth connection or a supply connection are tested in accordance with the relevant clauses of the main part of this standard and normative Annex B.

NOTE A supply connection can include a mains connection.

Battery-operated appliances having a supply connection are considered dual supply appliances. Dual supply appliances are regarded as **battery-operated appliances** when deriving their energy from **batteries**.

Separable batteries and **detachable batteries** for **battery-operated appliances** are tested in accordance with normative Annex B.

5.18 To condition **batteries** that are rechargeable, the **batteries** shall be **fully discharged** and then **fully charged** in accordance with the appliance manufacturer's instructions. The sequence shall be repeated at least 2 h after the **battery** was charged.

For **batteries** where there is a series arrangement of parallel clusters of **cells**, the cluster shall be treated as a single **cell** for those tests that require altering the amount of charge on a single **cell** prior to conducting the test.

5.19 Measurements of **cell** voltages or **battery** voltages shall be made using a single pole resistive-capacitive low pass filter with a -3 dB roll off frequency of $5\text{ kHz} \pm 0,5\text{ kHz}$. To determine if the **upper limit charging voltage** has been exceeded, the peak value of the filtered voltage shall be measured with a tolerance of $\pm 1\%$.

When measuring **cell** voltages or **battery** voltages, the peak value of any superimposed ripple exceeding 10 % of the average value shall be included. Transient voltages are ignored, such as a temporary increase of voltage, for example, after the **battery** is removed from the **charging system**.

5.20 If linear and angular dimensions are specified without a tolerance, ISO 2768-1 is applicable.

5.21 Probes are applied with a force not exceeding 1 N.

5.22 If a component or part of the appliance has both a **self-resetting feature** and a **non-self-resetting feature** and if the **non-self-resetting feature** is not required in order to comply with this standard, then appliances incorporating such a component or part shall be tested with the **non-self-resetting feature** rendered inoperative.

6 Classification

6.1 Appliances shall be of one of the following classes with respect to protection against electric shock:

class 0, class 0I, class I, class II, class III.

If an appliance consists of a part of **class III construction** and a **detachable power supply part**, the complete appliance is classified as a **class I appliance** or **class II appliance** in accordance with the classification applicable to its **detachable power supply part**.

Compliance is checked by inspection and by the relevant tests.

Modification:

Appliance shall be of **class I, class II or class III.**

6.2 Appliances shall have the appropriate degree of protection against harmful ingress of water.

Compliance is checked by inspection and by the relevant tests.

NOTE The degrees of protection against harmful ingress of water are given in IEC 60529:1989 including IEC 60529:1989/AMD1:1999 and IEC 60529:1989/AMD2:2013.

Appliances shall be classified according to degree of protection against harmful ingress of water in accordance with IEC 60529:

- appliances or parts of appliances intended for outdoor use shall be at least IPX4;
- appliances intended only for indoor use (excluding laundry rooms) may be IPX0;
- appliances intended to be used in laundry rooms shall be at least IPX1.

6.101 Appliances shall be classified according to the accessibility either as **appliance accessible to the general public** or as **appliance not accessible to the general public**.

Compliance is checked by inspection.

7 Marking and instructions

7.1 Appliances shall be marked with the:

- **rated voltage** or **rated voltage range** in volts;
- symbol for nature of supply including number of phases, unless for single phase operation;
- **rated power input** in watts or **rated current** in amperes;
- name, trade mark or identification mark of the manufacturer or responsible vendor;
- model or type reference;
- symbol IEC 60417-5172 (2003-02) for **class II appliances** only;
- IP number according to degree of protection against ingress of water, other than IPX0;
- symbol IEC 60417-5180 (2003-02), for **class III appliances**. This marking is not necessary for appliances operated only by **batteries** (primary **batteries** or secondary **batteries** recharged outside of the appliance) or appliances powered by **rechargeable batteries** recharged in the appliance.
- **rated frequency**;
- **refrigerant charge** for each **refrigerating system**;
- refrigerant designation in accordance with ISO 817;
- **maximum allowable pressure** for the storage tank (for **sanitary hot water heat pumps**);
- **maximum allowable pressure** in the water and/or brine circuit for the **heat exchanger** for **hydronic fan coil units**;
- **maximum allowable pressure** for the refrigerant circuit; if the **maximum allowable pressures** for the suction and discharge side differ, a separate marking is required;
- for **pre-charged pipe sets**
 - refrigerant designation in accordance with ISO 817;
 - the **refrigerant charge** in the line set;
 - **maximum allowable pressure**;
 - if charged with a flammable refrigerant, the flame symbol ISO 7010-W021 (2011-05) including the safety group per ISO 817;
- ratings in watts and voltage of a **UV-C germicidal lamp system** if employed.

Appliances shall be marked with all of the designations and the rated inputs of the **supplementary heaters** for which they are intended to be used and shall have provision for identifying the actual heater that is field installed.

Unless it is evident from the design, the enclosure of the appliance shall be marked, by words or by symbols, with the direction of the fluid flow.

If a **flammable refrigerant** is used, a warning symbol (flame symbol: ISO 7010-W021 (2011-05)) including the safety group per ISO 817 as described in 7.6 shall be placed within sight of the marking of the refrigerant designation on the appliance. The height of the symbol shall be at least 10 mm, and it is not necessary for the symbol to be in colour.

NOTE 101 The refrigerant designation is typically found on the *name plate of the appliance*.

Appliances using **flammable refrigerants** shall be marked with the flame symbol ISO 7010-W021 (2011-05) including the safety group per ISO 817. The height of the triangle used for the symbol shall be at least 30 mm. The required markings shall be provided on all units which contain compressors.

If not already visible when accessing a **service port** and if a **service port** is provided, the **service port** shall be marked to identify the type of refrigerant. If the refrigerant is flammable, symbol ISO 7010-W021 (2011-05) including the safety group per ISO 817 shall be included, without specifying the colour.

If a **flammable refrigerant** is used, the symbols for "read operator's manual" (symbols ISO 7000-0790 (2004-01)) and "service indicator; read technical manual" (ISO 7000-1659 (2004-01)) shall be placed on the appliance in locations visible to the persons required to know the information. The height of the symbol shall be at least 10 mm.

Appliances which are not **fixed appliances**, using a **flammable refrigerant** with a **refrigerant charge** (m_c) of the appliance greater than m_1 according to GG.1.2, shall be marked with symbol ISO 7000-0434A (2004-01) immediately followed by the minimum room floor area symbol IEC 60417-6412 (2019-03), where "A" is the minimum room area in m² as determined according to Annex GG. The markings shall be placed on the outside of the appliance such that it is visible during normal operation.

Appliances employing **refrigerating systems** with **maximum allowable pressures** greater than 7 MPa shall be marked with symbol ISO 7000-1701 (2004-01) followed by the text "(X) MPa" and the "read operator's manual", ISO 7000-0790 (2004-01), where: "X" is the **maximum allowable pressure**.

NOTE If the appliance is marked with rated pressure, the units used can be bars but only together with pascals and placed in brackets.

Appliance outlets accessible to the user and socket-outlets accessible to the user:

- that are incorporated in appliances connected to the supply mains; and
- that operate at **rated voltage**

shall be marked with their **outlet load** in watts or amperes.

Appliances intended to be supplied from a **detachable power supply part** for the purposes of recharging the **battery** shall be marked with symbol ISO 7000-0790 (2004-01). They shall also be marked with symbol IEC 60417-6181 (2016-01) and the model or type reference of the **detachable power supply part** or with the substance of the following:

Use only with <model or type reference> supply unit

Class II appliances and **class III appliances** incorporating a functional earth shall be marked with the symbol IEC 60417-5018 (2011-07).

The enclosure of electrically-operated water valves incorporated in external hose-sets for connection of an appliance to the water mains shall be marked with symbol IEC 60417-5036 (2002-10) if their **working voltage** exceeds **extra-low voltage**.

Compliance is checked by inspection.

7.2 Stationary appliances for multiple supply shall be marked with the substance of the following:

Warning: Before obtaining access to terminals, all supply circuits must be disconnected

This warning shall be placed in the vicinity of the terminal cover.

Compliance is checked by inspection.

7.3 Appliances having a range of rated values and which can be operated without adjustment throughout the range shall be marked with the lower and upper limits of the range separated by a hyphen.

NOTE 1 Example: 115 V – 230 V: The appliance is suitable for any value within the marked range (a curling iron with a **PTC heating element** or an appliance incorporating an input switch mode power supply).

Appliances having different rated values and which have to be adjusted for use at a particular value by the user or installer shall be marked with the different values separated by an oblique stroke. This requirement is also applicable to appliances with provision for connection to both single-phase and multi-phase supplies.

NOTE 2 Example: 115/230 V: The appliance is only suitable for the marked values (an appliance with a selector switch).

NOTE 3 Example: 230 V ~/400 V 3N~: The appliance is only suitable for the voltage values indicated, 230 V~ being for single-phase, AC operation and 400 V 3N~ for three-phase, AC with neutral operation (an appliance with terminals for both supplies).

Compliance is checked by inspection.

7.4 If the appliance can be adjusted for different **rated voltages** or **rated frequencies**, the voltage or the frequency to which the appliance is adjusted shall be clearly discernible. If frequent changes in voltage setting or frequency setting are not required, this requirement is considered to be met if the **rated voltage** or **rated frequency** to which the appliance is to be adjusted can be determined from a wiring diagram fixed to the appliance.

The wiring diagram may be on the inside of a cover that has to be removed to connect the supply conductors. It shall not be on a label loosely attached to the appliance.

Compliance is checked by inspection.

7.5 For appliances marked with more than one **rated voltage** or with one or more **rated voltage ranges**, the **rated power input** or **rated current** for each of these voltages or ranges shall be marked. However, if the difference between the limits of a **rated voltage range** does not exceed 10 % of the arithmetic mean value of the range, the marking for **rated power input** or **rated current** may be related to the arithmetic mean value of the range.

The upper and lower limits of the **rated power input** or **rated current** shall be marked on the appliance so that the relation between input and voltage is clear.

Compliance is checked by inspection.

7.6 When symbols are used, they shall be as follows:

— — —	[symbol IEC 60417-5031 (2002-10)]	direct current

	[symbol IEC 60417-5032 (2002-10)]	alternating current
3	[symbol IEC 60417-5032-1 (2002-10)]	three-phase alternating current
3N	[symbol IEC 60417-5032-2 (2002-10)]	three-phase alternating current with neutral
	[symbol IEC 60417-5016 (2002-10)]	fuse-link

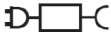
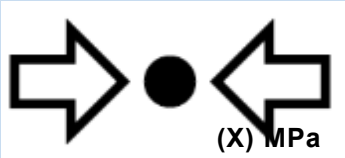
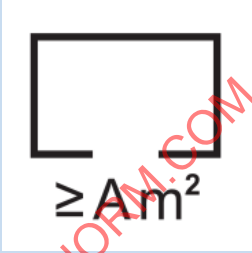
NOTE 1 The current rating of the fuse link can be indicated in association with this symbol.

		time-lag miniature fuse-link where X is the symbol for the time/current characteristic as given in IEC 60127

	[symbol IEC 60417-5019 (2006-08)]	protective earth
	[symbol IEC 60417-5018 (2011-07)]	functional earthing
	[symbol IEC 60417-5172 (2003-02)]	class II equipment
	[symbol IEC 60417-5012 (2002-10)]	Lamp

NOTE 2 The rated wattage of the lamp can be indicated in association with this symbol.

	[symbol ISO 7000-0434A (2004-01)]	Caution
	[symbol ISO 7000-0790 (2004-01)]	read operator's manual
	[symbol IEC 60417-5021 (2002-10)]	Equipotentiality
	[symbol IEC 60417-5036 (2002-10)]	dangerous voltage

	[symbol IEC 60417-5180 (2003-02)]	Class III appliance
	[symbol IEC 60417-6181 (2016-01)]	detachable power supply part
	[symbol ISO 7000-1659 (2004-01)]	service indicator; read technical manual
 safety group per ISO 817	[symbol ISO 7010-W021 (2011-05) plus the safety group per ISO 817 not less than 1/3 of the height of the symbol adjacent to the symbol]	warning; flammable material
	[symbol ISO 7000-1701 (2004-01)]	pressure
	[symbol IEC 60417-6040 (2010-08)]	ultraviolet radiation, instructional safeguard
	[symbol IEC 60417-6412 (2019-03)]	minimum room floor area

The symbol for nature of supply shall be placed next to the marking for **rated voltage**.

The symbol for **class II appliances** shall be placed so that it will be obvious that it is a part of the technical information and is unlikely to be confused with any other marking.

Units of physical quantities and their symbols shall be those of the international standardized system.

Additional symbols are allowed provided that they do not give rise to misunderstanding.

Symbols specified in IEC 60417 and ISO 7000 may be used.

Compliance is checked by inspection.

7.7 Appliances to be connected to more than two supply conductors and appliances for multiple supply shall have a connection diagram fixed to them, unless the correct mode of connection is obvious.

The correct mode of connection for multi-phase appliances is considered to be obvious if the terminals for the supply conductors are

- indicated by arrows pointing towards the terminals; or
- marked in words.

The connection diagram may be the wiring diagram referred to in 7.4.

Compliance is checked by inspection.

7.8 Except for **type Z attachment**, terminals used for connection to the supply mains shall be indicated as follows:

- terminals intended exclusively for the neutral conductor shall be indicated by the letter N;
- protective earthing terminals shall be indicated by symbol IEC 60417-5019 (2006-08);
- functional earthing terminals shall be indicated by symbol IEC 60417-5018 (2011-07).

These indications shall not be placed on screws, removable washers or other parts which can be removed when conductors are being connected.

Compliance is checked by inspection.

7.9 Unless it is obviously unnecessary, switches which may give rise to a hazard when operated shall be marked or placed so as to indicate clearly which part of the appliance they control. Indications used for this purpose shall, wherever practicable, be comprehensible without a knowledge of languages or national standards.

Compliance is checked by inspection.

7.10 The different positions of switches on **stationary appliances** and the different positions of controls on all appliances shall be indicated by figures, letters or other visual means. This requirement also applies to switches which are part of a control.

If figures are used for indicating the different positions, the **off position** shall be indicated by the figure 0 and the position for a higher value, such as output, input, speed or cooling effect, shall be indicated by a higher figure.

The figure 0 shall not be used for any other indication unless it is positioned and associated with other numbers so that it does not give rise to confusion with the indication of the **off position**. The figure 0 may be used on a digital programming keyboard.

Compliance is checked by inspection.

7.11 Controls intended to be adjusted during installation or in normal use shall be provided with an indication for the direction of adjustment.

NOTE An indication of + and – is considered to be sufficient.

Compliance is checked by inspection.

7.12 Instructions shall be provided in hard copy form with the appliance so that the appliance can be used safely.

Instructions may be marked on the appliance as long as they are visible in normal use.

NOTE If the instructions are marked on the appliance they are considered to be provided in hard copy form.

If it is necessary to take precautions during **user maintenance**, appropriate details shall be given.

The instructions shall state the substance of the following:

This appliance is not intended for use by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction concerning use of the appliance by a person responsible for their safety.

Children should be supervised to ensure that they do not play with the appliance.

The instructions for appliances having a part of **class III construction** supplied from a **detachable power supply part** shall state that the appliance is only to be used with the power supply unit provided with the appliance.

The instructions for **class III appliances** shall state that it must only be supplied at safety extra-low voltage corresponding to the marking on the appliance. This instruction is not necessary for **battery-operated appliances** if the **battery** is a primary **battery** or secondary **battery** charged outside of the appliance.

For appliances intended for use at altitudes exceeding 2 000 m, the maximum altitude of use shall be stated.

The instructions for appliances incorporating a functional earth shall state the substance of the following:

This appliance incorporates an earth connection for functional purposes.

For appliances intended to be connected to a supply for the purposes of recharging the **battery**, the instructions shall state the substance of the following:

WARNING: Use only an external supply with the following specifications: <voltage and nature of supply> <power / current of supply>

For appliances intended to be supplied from a **detachable power supply part** for the purposes of recharging the **battery**, the type reference of the **detachable power supply part** shall be stated along with the substance of the following:

WARNING: Only use the supply unit provided with this appliance.

For appliances intended for use with **batteries** that use metal-ion chemistries, the instructions shall state the normal temperature range for charging the **battery**.

If the symbol for **detachable power supply part** is used, its meaning shall be explained.

Compliance is checked by inspection.

7.12.1 If it is necessary to take precautions during installation of the appliance, appropriate details shall be given.

If an appliance is intended to be permanently connected to the water mains and not connected by a hose-set, this shall be stated.

For appliances marked with different **rated voltages** or different **rated frequencies** (separated by a /), instructions shall be included to indicate to the user or installer what action must be taken to adjust the appliance for operation at the required **rated voltage** or **rated frequency**.

In particular, the following information shall be supplied:

- a) that national wiring regulations can impose additional requirements;
- b) the dimensions of the space necessary for correct installation of the appliance including the minimum permissible distances to adjacent structures;
- c) for appliances with **supplementary air heaters**, the minimum clearance from the appliance to combustible surfaces;
- d) a wiring diagram with a clear indication of the connections and wiring to external control devices and **supply cord**;
- e) the range of external static pressures at which the appliance was tested (add-on **heat pumps** and ducted appliances with **supplementary air heaters** only);
- f) the method of connection of the appliance to the electrical supply and interconnection of separate components;
- g) indication of which parts of the appliance are suitable for outdoor use, if applicable;
- h) details of type and rating of fuses, or rating of circuit breakers;
- i) details of supplementary heating elements that may be used in conjunction with the appliance, including fitting instructions either with the appliance or with the **supplementary heater**;
- j) maximum and minimum water or brine operating temperatures;
- k) maximum and minimum water or brine operating pressures;
- l) maximum and minimum operating indoor and outdoor air temperatures;
- m) instructions on charging of refrigerants when addition of charge is required by the manufacturer for completing the **refrigerating system**;
- n) when the symbol IEC 60417-6412 (2019-03) is used, a warning that the appliance shall be installed, operated and stored in a room with a floor area not less than the minimum room area.

Open storage tanks of **heat pumps** for water heating shall be accompanied by an instruction sheet stating that the vent shall not be obstructed.

Compliance is checked by inspection.

7.12.2 If a **stationary appliance** is not fitted with a **supply cord** and a plug, or with other means for disconnection from the supply mains having a contact separation in all poles that provide full disconnection under overvoltage category III conditions, the instructions shall state that means for disconnection must be incorporated in the fixed wiring in accordance with the wiring rules.

Compliance is checked by inspection.

7.12.3 If the insulation of the fixed wiring supplying an appliance for permanent connection to the supply mains can come into contact with parts having temperature rise exceeding 50 K during the test of Clause 11, the instructions shall state that the fixed wiring insulation must be protected, for example, by insulating sleeving having an appropriate temperature rating.

Compliance is checked by inspection and during the test of Clause 11.

7.12.4 The instructions for **built-in appliances** shall include information with regard to the following:

- dimensions of the space to be provided for the appliance;
- dimensions and position of the means for supporting and fixing the appliance within this space;
- minimum distances between the various parts of the appliance and the surrounding structure;

- minimum dimensions of ventilating openings and their correct arrangement;
- connection of the appliance to the supply mains and the interconnection of any separate components;
- necessity to allow disconnection of the appliance from the supply after installation, unless the appliance incorporates a switch complying with 24.3. The disconnection may be achieved by having the plug accessible or by incorporating a switch in the fixed wiring in accordance with the wiring rules.

Compliance is checked by inspection.

7.12.5 For appliances with **type X attachment** having a specially prepared cord, the instructions shall contain the substance of the following:

If the supply cord is damaged, it must be replaced by a special cord or assembly available from the manufacturer or its service agent.

For appliances with **type Y attachment**, the instructions shall contain the substance of the following:

If the supply cord is damaged, it must be replaced by the manufacturer, its service agent or similarly qualified persons in order to avoid a hazard.

For appliances with **type Z attachment**, the instructions shall contain the substance of the following:

The supply cord cannot be replaced. If the cord is damaged, the appliance should be scrapped.

If a cord set is required to be provided with the appliance according to Subclause 22.58, the instructions shall contain the substance of the following:

If the cord set is damaged, it must be replaced by a special cord set available from the manufacturer or its service agent.

Compliance is checked by inspection.

7.12.6 If a **non-self-resetting thermal cut-out** is required in order to comply with this standard, then the instructions for appliances incorporating a **non-self-resetting thermal cut-out** that is reset by disconnection of the supply mains shall contain the substance of the following:

CAUTION: In order to avoid a hazard due to inadvertent resetting of the thermal cut-out, this appliance must not be supplied through an external switching device, such as a timer, or connected to a circuit that is regularly switched on and off by the utility.

Compliance is checked by inspection.

7.12.7 The instructions for **fixed appliances** shall state how the appliance is to be fixed to its support. The method of fixing stated is not to depend on the use of adhesives since they are not considered to be a reliable fixing means.

Compliance is checked by inspection.

7.12.8 The instructions for appliances connected to the water mains shall state:

- the maximum inlet water pressure, in pascals;
- the minimum inlet water pressure, in pascals, if this is necessary for the correct operation of the appliance.

The instructions for appliances connected to the water mains by **detachable hose-sets** shall state that the new hose-sets supplied with the appliance are to be used and that old hose-sets should not be reused.

Compliance is checked by inspection.

7.12.9 For each language, the instructions specified in 7.12 and from 7.12.1 to 7.12.8, 7.12.101 and 7.12.102 shall be in hard copy form and shall appear together before any other instructions supplied with the appliance. Alternatively, these instructions may be supplied with the appliance separately from any functional use booklet. They may follow the description of the appliance that identifies parts, or follow the drawings/sketches common to the languages of the instructions.

In addition, instructions shall also be available in an alternative format such as on a website or on request from the user in a format such as a DVD.

Compliance is checked by inspection.

7.12.101 For **appliances not accessible to the general public**, the classification according to 6.101 shall be included.

Compliance is checked by inspection.

7.12.102 For **appliances** using **flammable refrigerants**, installation instructions, service, maintenance and repair instructions, and decommissioning instructions, either as separate or combined instructions, shall be made available and include the information given in Annex DD.

Compliance is checked by inspection.

Additional guidance on transportation, marking and storage for units that employ **flammable refrigerants** is given in Annex CC.

7.13 Instructions and other text required by this standard shall be written in an official language of the country in which the appliance is to be sold.

Compliance is checked by inspection.

7.14 The markings required by this standard shall be clearly legible.

The signal words WARNING, CAUTION, DANGER if in the Latin alphabet shall be in uppercase having a height not less than:

- 3,5 mm for appliances normally used on the floor;
- 2,0 mm for **portable appliances** with a printable surface of less than 10 cm²; and
- 3,0 mm for other appliances.

NOTE A height of 3,5 mm is similar to Arial 14 pt, 3,0 mm is similar to 12 pt Arial and 2,0 mm is similar to 8 pt Arial. Other typefaces might differ in the pt value.

Uppercase letter of the text explaining the signal word shall be no smaller than 1,6 mm, with other letters according to the font size of the uppercase letter.

Countries that do not use the Latin alphabet need to specify the minimum size of the script to be used taking into account what is specified for the Latin alphabet.

Unless contrasting colours are used, moulded in, engraved, or stamped markings shall be either raised above or have a depth below the surface of at least 0,25 mm.

The markings required by this standard shall be durable. On containers that are likely to be cleaned frequently, the markings shall not be by means of paint or enamel, other than vitreous enamel.

Compliance is checked by inspection, by measurement and by rubbing the marking by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked with petroleum spirit. The petroleum spirit to be used for the test is aliphatic solvent hexane.

After all the tests of this standard, the marking shall be clearly legible. It shall not be easily possible to remove marking plates nor shall they show curling.

7.15 The markings specified in 7.1 to 7.5 shall be on a main part of the appliance.

Markings on the appliance shall be clearly discernible from the outside of the appliance but if necessary after removal of a cover. For **portable appliances**, it shall be possible to remove or open this cover without the aid of a **tool**.

For **stationary appliances**, at least the name or trademark or identification mark of the manufacturer or responsible vendor and the model or type reference shall be visible when the appliance is installed as in normal use. These markings may be beneath a **detachable cover**. Other markings may be beneath a cover only if they are near to the terminals. For **fixed appliances**, this requirement applies after the appliance has been installed according to the instructions provided with the appliance.

Indications for switches and controls shall be placed on or near these components. They shall not be placed on parts which can be positioned or repositioned in such a way that the marking is misleading.

The symbol IEC 60417-5018 (2011-07) shall be placed next to the symbol IEC 60417-5172 (2003-02) or the symbol IEC 60417-5180 (2003-02) as appropriate.

The type reference of the **detachable power supply part** shall be placed next to symbol IEC 60417-6181 (2016-01).

The marking of the **outlet load** shall be on the appliance close to the appliance outlet or socket-outlet.

A marking may be located on a panel that can be removed for installation or service, providing that the panel shall be in place for the intended operation of the appliance.

Compliance is checked by inspection.

7.16 If compliance with this standard depends upon the operation of a replaceable **thermal link** or fuse link, the reference number or other means for identifying the link shall be marked at such a place that it is clearly visible when the appliance has been dismantled to the extent necessary for replacing the link.

NOTE Marking on the link is allowed as long as the marking is legible after the link has functioned.

This requirement does not apply to links which can only be replaced together with a part of the appliance.

Compliance is checked by inspection.

7.101 A marking shall be provided for a replaceable fuse or a replaceable overload **protective device** provided as a part of a product or remote control assembly. It shall be visible when the cover or door of the compartment is open. This marking shall specify

- the rating of the fuse in amperes, the type and voltage rating, or
- the manufacturer and model designation of the replaceable overload **protective device**.

Compliance is checked by inspection.

7.102 If the appliance is intended for permanent connection to fixed wiring with aluminium wires, the marking shall so state.

Compliance is checked by inspection.

7.103 For appliances made up of more than one factory made assembly specified by the manufacturer to be used together, instructions shall be provided for completing the assembly to ensure compliance with the requirements.

Compliance is checked by inspection.

7.104 For **partial units**, the instructions or markings shall include the following additional information.

- For **evaporating units** and **condensing units**, the instructions or markings shall include wording to assure that the maximum operating pressure is considered when connecting to any **condenser unit** or **evaporator unit**.
- For **evaporating units**, **condensing units** and **condenser units**, the instructions or markings shall include refrigerant charging instructions.
- A warning to ensure that **partial units** shall only be connected to an appliance suitable for the same refrigerant.
- This unit <model xxx> is a **partial unit air-conditioner**, complying with **partial unit** requirements of IEC 60335-2-40, and must only be connected to other units that have been confirmed as complying to corresponding **partial unit** requirements of IEC 60335-2-40.
- The electrical interfaces shall be specified with purpose, voltage, current, and safety class of construction.
- The **SELV** connection points, if provided, are to be clearly indicated in the instructions. The connection point should be marked with the "read the instructions" symbol per ISO 7000-0790 (2004-01) and the Class III symbol according to IEC 60417-5180 (2003-02).

Compliance is checked by inspection.

7.105 For appliances using **flammable refrigerants** that have safety features depending upon the proper function of a **leak detection system**, the instructions or unit markings shall contain the substance of the following:

"This unit is equipped with a **leak detection system** for safety. For leak detection to be effective, the unit must be electrically powered at all times after installation, other than when servicing."

If any remote located **refrigerant sensor** is employed to detect leaked refrigerant, such remote located **refrigerant sensor** shall also apply this marking or be accompanied by such instructions.

Compliance is checked by inspection.

7.106 For appliances using **flammable refrigerants** that have safety features depending upon the proper function of electrically powered safety measures, the instructions or unit markings shall contain the substance of the following:

"This unit is equipped with electrically powered safety measures. For the safety measures to be effective, the unit must be electrically powered at all times after installation, other than when servicing."

If any mechanical ventilation unit is employed to dilute leaked refrigerant and is not integrated in the appliance, such unit shall also apply this marking or be accompanied by such instructions.

Compliance is checked by inspection.

7.107 For **flammable refrigerants**, when addition of charge is required by the installation instructions for completing the **refrigerating system**, the manufacturer shall provide a label that allows the installer to note the resulting total **refrigerant charge** for each **refrigerating system**. See Figure 101 for an example of a label for field charged units.

Compliance is checked by inspection.

7.108 For appliances using **flammable refrigerants**, excluding appliances with **A2L refrigerant charge** not exceeding m_1 , the flame symbol ISO 7010-W021 (2011-05) including the safety group per Annex BB described in 7.6 shall be visible on the packaging of the appliance if the appliance is charged with refrigerant.

The perpendicular height of the symbol shall be at least 30 mm.

Compliance is checked by inspection.

7.109 Appliances employing **UV-C germicidal lamp systems** shall be marked with **ultraviolet radiation** hazard symbol IEC 60417-6040 (2010-08) and the read operator's manual symbol ISO 7000-0790 (2004-01) in the following locations:

- doors and access panels that provide direct access to an area within the appliance where the measured **UV-C spectral irradiance** is greater than $1,7 \mu\text{W}/\text{cm}^2$;
- **user maintenance** access panels,
- **UV-C barriers**.

Compliance is checked by inspection.

7.110 For appliances that employ **UV-C germicidal lamp systems**, the instructions shall include the substance of the following:

- this appliance contains a **UV-C lamp**;
- read the maintenance instructions before opening the appliance;
- details for cleaning and other **user maintenance** of the appliance. They shall state that prior to cleaning or other maintenance, the appliance must be disconnected from the supply mains;
- the method, frequency of cleaning, and necessary precautions to be taken;
- precautions to be taken when replacing UV-C emitters and starters, if applicable;
- unintended use of the appliance or damage to the housing can result in the escape of dangerous UV-C radiation. UV-C radiation can, even in small doses, cause harm to the eyes and skin;
- appliances that are obviously damaged must not be operated;
- the appliance must be disconnected from the supply before replacing the **UV-C lamp**;

- doors and access panels bearing the **ultraviolet radiation** hazard symbol which can have **UV-C spectral irradiance** greater than $1,7 \mu\text{W}/\text{cm}^2$ are provided with an interlock switch to interrupt the power to the **UV-C lamps** for your safety. Do not over-ride;
- before opening doors and access panels bearing the **ultraviolet radiation** hazard symbol for conducting the **user maintenance**, it is recommended to disconnect the power;
- **UV-C barriers** bearing the **ultraviolet radiation** hazard symbol should not be removed;
- for appliances with **UV-C lamps**, information on the replacement of **UV-C lamps** shall be given, including the model and/or part number;
- if field installed, the factory specified **UV-C germicidal lamp systems** approved for use with the appliance shall be specified in the instructions by the specific model number;
- do not operate **UV-C lamps** outside of the appliance.

Compliance is checked by inspection.

7.111 Appliances employing **refrigerating systems** with **maximum allowable pressures** greater than 7 MPa shall be marked within sight of the refrigerant service ports with the following:

- the symbol ISO 7000-1701 (2004-01) including the text "(X) MPa", where; "X" is not less than the **maximum allowable pressure**.

Compliance is checked by inspection.

8 Protection against access to live parts

8.1 Appliances shall be constructed and enclosed so that there is adequate protection against accidental contact with **live parts**.

Compliance is checked by inspection and by the tests of 8.1.1 to 8.1.3, as applicable, taking into account 8.1.4 and 8.1.5.

8.1.1 The requirement of 8.1 applies for all positions of the appliance when it is operated as in normal use, and after the removal of **detachable parts**, unless otherwise specified.

Test probe B and test probe 18 of IEC 61032 are applied with a force not exceeding 1 N, the appliance being in every possible position, except that appliances normally used on the floor and having a mass exceeding 40 kg are not tilted. Through openings, the test probe is applied to any depth that the probe will permit and is rotated or angled before, during and after insertion to any position. If the opening does not allow the entry of the probe, the force on the probe in the straight position is increased to 20 N when probe B is used or 10 N when probe 18 is used. If the probe then enters the opening, the test is repeated with the probe in the angled position.

*During the tests with test probe B, all **detachable parts** are removed except lamps located behind a **detachable cover** are not removed, provided that the appliance can be isolated from the supply mains by means of a plug or an all-pole switch. However, during insertion or removal of lamps which are located behind a **detachable cover**, protection against contact with **live parts** of the lamp cap shall be ensured.*

During the tests with test probe 18, the appliance shall be fully assembled as in normal use without any parts removed.

Test probe 18 is not applied to appliances for commercial use unless they are intended to be installed in an area open to the public.

Test probe 18 of IEC 61032 is not applied to parts of appliances that according to the installation instructions are required to be mounted at a height exceeding 1,8 m above the floor.

*It shall not be possible to touch **live parts** or **live parts** protected only by lacquer, enamel, ordinary paper, cotton, oxide film, beads, or sealing compound except self-hardening resins, with the probe.*

8.1.2 Test probe 13 of IEC 61032 is applied with a force not exceeding 1 N through openings in **class 0 appliances**, **class II appliances** and **class II constructions**, except for those giving access to lamp caps and **live parts** in socket-outlets.

NOTE Appliance outlets are not considered to be socket-outlets.

The test probe is also applied through openings in earthed metal enclosures having a non-conductive coating such as enamel or lacquer.

*It shall not be possible to touch **live parts** with the test probe.*

8.1.3 Instead of test probe B, test probe 18 and test probe 13, for appliances other than those of **class II**, test probe 41 of IEC 61032 is applied with a force not exceeding 1 N to **live parts of visibly glowing heating elements**, all poles of which can be disconnected by a single switching action. It is also applied to parts supporting such elements, provided that it is obvious from the outside of the appliance, without removing covers and similar parts, that these supporting parts are in contact with the element.

*It shall not be possible to touch these **live parts**.*

*If a single switching action is obtained by a switching device, the switching device shall provide full disconnection and the **clearances** for full disconnection specified in 20.3.3 of IEC 61058-1:2016 shall be obtained from Table 12 of IEC 61058-1:2016 using the next higher step for rated impulse withstand voltage.*

*For appliances provided with a **supply cord** and without a switching device in their supply circuit, a single switching action may be obtained by the withdrawal of the plug from a socket-outlet.*

Compliance is checked by inspection and by manual test.

8.1.4 An **accessible part** is not considered to be live if:

- the part is supplied at **safety extra-low voltage**, provided that
 - for AC, the peak value of the voltage does not exceed 42,4 V;
 - for DC, the voltage does not exceed 42,4 V;

or

- the part is separated from **live parts** by **protective impedance**.

If **protective impedance** is used, the current between the part and the supply source shall not exceed 2 mA for DC, its peak value shall not exceed 0,7 mA for AC and

- for voltages having a peak value over 42,4 V up to and including 450 V, the capacitance shall not exceed 0,1 μF ;
- for voltages having a peak value over 450 V up to and including 15 kV, the discharge shall not exceed 45 μC ;
- for voltages having a peak value over 15 kV, the energy in the discharge shall not exceed 350 mJ.

*Compliance is checked by measurement, the appliance being supplied at **rated voltage**.*

Voltages and currents are measured between the relevant parts and each pole of the supply source. Discharges are measured immediately after the interruption of the supply. The quantity of electricity and energy in the discharge is measured using a resistor having a nominal non-inductive resistance of 2 000 Ω .

The quantity of electricity is calculated from the sum of all areas recorded on the voltage/time graph without taking voltage polarity into account. Details of a suitable circuit for measuring the current are given in Figure 4 of IEC 60990:2016.

8.1.5 Live parts of built-in appliances, fixed appliances and appliances delivered in separate units, shall be protected at least by **basic insulation** before installation or assembly.

Compliance is checked by inspection and by applying test probe B of IEC 61032 as specified in 8.1.1.

For appliances which have a dedicated installation panel or cover and which cannot be installed without them, compliance is checked according to 5.10 (after installation according to the installation instructions).

8.2 Class II appliances and **class II constructions** shall be constructed and enclosed so that there is adequate protection against accidental contact with **basic insulation** and metal parts separated from **live parts** by **basic insulation** only.

It shall only be possible to touch parts which are separated from **live parts** by **double insulation** or **reinforced insulation**.

Compliance is checked by inspection and by applying the test probes specified in 8.1.1 in accordance with the conditions specified in 8.1.1.

8.3 For a **battery-operated appliance** where the **battery** circuit has a functional earth connection or a supply connection, it shall only be possible to touch parts within a **battery** compartment where:

- in **class I appliances**, **class 0I appliances** and **class II appliances**, they are separated from **live parts** by **double insulation** or **reinforced insulation**;
- in **class 0 appliances**, they are separated from **live parts** by **basic insulation**;
- the **battery** compartment is of **class III construction**. However, if the limits in 8.1.4 are exceeded, then **basic insulation** is required in addition to supply at **SELV**.

Compliance is checked by inspection and by applying the test probes specified in 8.1.1 in accordance with the conditions specified in 8.1.1.

9 Starting of motor-operated appliances

This clause of Part 1 is not applicable.

10 Power input and current

10.1 If an appliance is marked with **rated power input**, the power input at normal operating temperature shall not deviate from the **rated power input** by more than the deviation shown in Table 1.

Table 1 – Power input deviation

Type of appliance	Rated power input W	Deviation
All appliances	≤25	+20 %
Heating appliances and combined appliances	>25 and ≤200	±10 %
	>200	+5 % or 20 W (whichever is the greater) –10 %
Motor-operated appliances	>25 and ≤300	+20 %
	>300	+15 % or 60 W (whichever is the greater)

The deviation for **motor-operated appliances** applies for **combined appliances** if the power input of the motors is more than 50 % of the **rated power input**. The permissible deviations apply for both limits of the range for appliances marked with a **rated voltage range** having limits differing by more than 10 % of the arithmetic mean value of the range.

In case of doubt, the power input of the motors may be measured separately.

Compliance is checked by measurement when the power input has stabilized with:

- *all circuits which can operate simultaneously being in operation;*
- *the appliance being supplied at **rated voltage**;*
- *the appliance being operated under **normal operation**.*

If the power input varies throughout the operating cycle and its maximum value exceeds twice its arithmetic mean value occurring during a representative period, then the power input is the maximum value of the power input that is exceeded for more than 10 % of the representative period if this value is greater than the arithmetic mean value. Otherwise the power input is taken as the arithmetic mean value.

NOTE Guidance on the measurement of power input concerning a representative period is given in informative Annex S.

*The test is carried out at both the upper and lower limits of the ranges for appliances marked with one or more **rated voltage ranges**, unless the marking of the **rated power input** is related to the arithmetic mean value of the relevant voltage range, in which case the test is carried out at a voltage equal to the arithmetic mean value of that range.*

Appliance outlets accessible to the user and socket-outlets accessible to the user that:

- *are incorporated in appliances connected to the supply mains; and*
- *operate at **rated voltage***

*are not loaded during the test; however, their contribution to the power input is considered to be the marked **outlet load** per appliance outlet or socket-outlet.*

10.2 If an appliance is marked with **rated current**, the current at normal operating temperature shall not deviate from the **rated current** by more than the deviation shown in Table 2.

Table 2 – Current deviation

Type of appliance	Rated current A	Deviation
All appliances	$\leq 0,2$	+20 %
Heating appliances and combined appliances	$>0,2$ and $\leq 1,0$	± 10 %
	$> 1,0$	+5 % or 0,10 A (whichever is the greater) –10 %
Motor-operated appliances	$>0,2$ and $\leq 1,5$	+20 %
	$> 1,5$	+15 % or 0,30 A (whichever is the greater)

The deviation for **motor-operated appliances** applies for **combined appliances** if the current of the motors is more than 50 % of the **rated current**. The permissible deviations apply for both limits of the range for appliances marked with a **rated voltage range** having limits differing by more than 10 % of the arithmetic mean value of the range.

In case of doubt, the current of the motors may be measured separately.

Compliance is checked by measurement when the current has stabilized with:

- all circuits which can operate simultaneously being in operation;
- the appliance being supplied at **rated voltage**;
- the appliance being operated under **normal operation**.

If the current varies throughout the operating cycle and its maximum value exceeds twice its arithmetic mean value occurring during a representative period, then the current is the maximum value of the current that is exceeded for more than 10 % of the representative period if this value is greater than the arithmetic mean value. Otherwise the current is taken as the arithmetic mean value.

NOTE Guidance on the measurement of current concerning a representative period is given in informative Annex S.

*The test is carried out at both the upper and lower limits of the ranges for appliances marked with one or more **rated voltage ranges**, unless the marking of the **rated current** is related to the arithmetic mean value of the relevant voltage range, in which case the test is carried out at a voltage equal to the arithmetic mean value of that range.*

Appliance outlets accessible to the user and socket-outlets accessible to the user that:

- are incorporated in appliances connected to the supply mains; and
- operate at **rated voltage**

*are not loaded during the test; however, their contribution to the current is considered to be the marked **outlet load** per appliance outlet or socket-outlet.*

11 Heating

11.1 Appliances and their surroundings shall not attain excessive temperatures in normal use.

Compliance is checked by determining the temperature rise of the various parts under the conditions specified in 11.2 to 11.7.

If the temperature of the motor winding exceeds the value specified in Table 3 or if there is doubt with regard to the classification of the insulation system employed in a motor, compliance is checked by the tests of Annex C.

11.2

11.2.1 Appliances are installed in one or more test rooms in accordance with the installation instructions. In particular,

- clearances to adjacent surfaces specified by the manufacturer shall be maintained;
- adjustable limit controls are set at the maximum cut-out setting and the minimum differential permitted by the control adjusting means.

For appliances provided with **supplementary air heaters**, an additional test casing as described in 11.2.5 is used.

11.2.2 For heating tests of ducted appliances with **supplementary air heaters**, an inlet duct is connected to the inlet air opening of the appliance (assuming that the appliance is intended to be so applied). The duct shall be the same size as the flanges, if flanges are provided. If flanges are not provided, the duct shall be the same size as the inlet opening.

An appliance that includes or has provision for **supplementary air heater** is fitted with an outlet duct in accordance with Figure 102a) or Figure 102b), depending on the direction of the airflow.

The inlet duct is provided with an adjustable restricting means by which the airflow can be reduced.

The restriction should be uniform across the duct's cross-sectional area, so that the full heating coil surface will be exposed to the airflow except when the restriction is closed.

For non-ducted appliances, other means may be used to uniformly restrict the inlet.

The distance from the air outlet opening of the appliance to the furthest point on the test duct, perpendicular to the outlet opening, shall be no more than the value of:

- for upflow appliances, $(AB)^{0.5}$ as shown in Figure 102a) or the minimum distance specified by the manufacturer, whichever is lower;
- for downflow appliances, $300 + (AB)^{0.5}$ as shown in Figure 102b) or the minimum distance specified by the manufacturer, whichever is lower.

NOTE 101 For horizontal ducted products, reference is made to Figure 102b), rotated 90° counter clockwise.

NOTE 102 Appliances can be specified by the manufacturer for use in applications with limited space for the appliance and connected ducts.

EXAMPLE 101 For upflow appliances intended for use in manufactured (mobile) homes, the combined height of the appliance and ducts is typically limited to 2,1 m (7 ft) minus the specified clearance to combustible material.

EXAMPLE 102 For downflow appliances intended for use in manufactured (mobile) homes, the distance from the air outlet opening to the furthest point on the test duct, perpendicular to the outlet opening, is typically reduced to not less than $25,4 + (AB)^{0.5}$.

11.2.3 A ducted appliance which does not include **supplementary air heaters**, is fitted with an outlet duct sized to fit the casing flanges, or opening without flanges, or locations marked for flanges, and arranged to discharge away from the return air inlet.

The hot air outlet duct is provided with a restricting means to obtain the maximum static pressure given in the instructions.

11.2.4 For the evaluation and testing of **partial units**, the following test set-up and conditions are to be applied:

- **evaporator units** and **condenser units** are tested as individual units at the maximum ambient temperature stated in the instructions. If not stated in the instructions, these units shall be tested at an ambient temperature that is equal to the saturated dew point temperature of the refrigerant at the marked **maximum allowable pressure** ($\pm 0,1$ MPa) minus 10 K (± 1 K);
- **condensing units** are tested in the cooling mode only, at the maximum specified ambient temperature with 9 K (± 1 K) sub-cooling and the maximum specified evaporating pressure with 11 K (± 1 K) superheat. For **condensing units** provided with expansion device(s), the superheat/sub-cooling is to be as under the normal control of the expansion device(s);
- **evaporating units**, intended for cooling only, are tested in the cooling mode only with a condensing pressure that is equal to the marked **maximum allowable pressure** ($\pm 0,1$ MPa) with 9 K (± 1 K) sub-cooling;
- **evaporating units** that are intended for reverse cycle operation are tested in the heating mode only, at the maximum specified evaporating pressure.

NOTE 101 Testing for **condensing units** and **evaporating units** requires connection to calorimeter stand or similar device capable of controlling the refrigerant entering and leaving conditions as specified in the test above. **Condenser units** and **evaporator units** do not require a calorimeter stand or similar device.

11.2.5 The test casing consists of plywood walls having a thickness of about 20 mm, with dull black painted inside surfaces and all joints sealed. The distances between the casing and the surfaces of the appliance and the outlet duct, if any, are equal to the minimum clearances according to the instructions.

For appliances not specified for installation with minimum clearances, as an alternative to the plywood test casing in direct contact with the appliance, glass fibre insulating material having a thickness of at least 25 mm and a density of at least 16 kg/m³ shall be wrapped closely around the appliance and the outlet duct, and thermocouples shall be placed in direct contact with the enclosure.

11.3 Temperatures other than those of windings are determined by means of thermocouples which are sized and so chosen and positioned that they have the minimum effect on the temperature of the part under test.

NOTE 101 Thermocouples having wires with a diameter not exceeding 0,3 mm are generally considered to have minimum effect on temperature when measuring small parts such as electronic components.

Thermocouples used for determining the temperature rise of the surface of walls, ceiling and floor of the test corner are attached to the back of small blackened disks of copper or brass, 15 mm in diameter and 1 mm thick. The front of the disk is flush with the surface of the board.

As far as is possible, the appliance is positioned so that the thermocouples detect the highest temperatures.

If it is necessary to dismantle the appliance to position thermocouples, verify that the appliance has been correctly reassembled. In case of doubt, remeasure the power input or input current as appropriate.

The temperature rise of electrical insulation, other than that of windings, is determined on the surface of the insulation at places where failure could cause:

- a short circuit;
- contact between **live parts** and **accessible metal parts**;
- bridging of insulation;
- a reduction of **clearances** or **creepage distances** below the values specified in Clause 29.

NOTE 1 The point of separation of the cores of a multicore cord and the point where insulated wires enter lampholders are examples of places where thermocouples are positioned.

Temperature rises of windings are determined by the resistance method unless the windings are non-uniform or if it is difficult to make the necessary connections, in which case the temperature rise is determined by means of thermocouples. At the beginning of the test, the windings are to be at **room temperature**.

The temperature rise of a winding is calculated from the formula:

$$\Delta t = \frac{R_2 - R_1}{R_1} (k + t_1) - (t_2 - t_1)$$

where

Δt is the temperature rise of the winding;

R_1 is the resistance at the beginning of the test;

R_2 is the resistance at the end of the test;

k is equal to

- 225 for aluminium windings and copper/aluminium windings with an aluminium content ≥ 85 %,
- 229,75 for copper/aluminium windings with an copper content > 15 % to < 85 %,
- 234,5 for copper windings and copper/aluminium windings with an copper content ≥ 85 %;

t_1 is **room temperature** at the beginning of the test;

t_2 is **room temperature** at the end of the test.

NOTE 2 The resistance of windings at the end of the test can be determined by taking resistance measurements as soon as possible after switching off and then at short intervals so that a curve of resistance against time can be plotted for ascertaining the resistance at the instant of switching off.

The temperatures in the duct are to be measured by means of a thermocouple grid consisting of nine thermocouples of identical length, wired in parallel to form a grid with a thermocouple located centrally in each of nine equal duct areas in a plane perpendicular to the axis of the airflow. For non-ducted appliances, the thermocouple grid shall be located within 25 mm of the outlet air opening and perpendicular to the opening. The temperature of the air measured by the thermocouple grid shall not exceed 92 °C.

11.4 Appliances are operated under **normal operation** at a supply voltage between 0,94 times the lowest **rated voltage** and 1,06 times the highest **rated voltage**, the voltage chosen being that which gives the most unfavourable result.

11.5 This subclause of Part 1 is not applicable.

11.6 This subclause of Part 1 is not applicable.

11.7 The appliance is operated for a duration corresponding to the most unfavourable conditions of normal use.

Appliance outlets accessible to the user and socket-outlets accessible to the user are loaded with a resistive load that gives the marked **outlet load**.

For appliances incorporating **integral batteries** or **separable batteries** not disconnected from the appliance for charging purposes:

- the **battery** that has been **fully discharged** is charged for 1 h, while the appliance is operated continuously performing its intended function, if allowed by the construction of the appliance;
- the **battery** that has been **fully discharged** is charged, for a duration of 24 h or until it is **fully charged** whichever is shorter, without the **battery-operated appliance** performing its intended function.

NOTE The duration of the test can consist of more than one cycle of operation.

Where an appliance can be operated in the cooling mode as well as the heating mode, a test is conducted in each mode.

Appliances with defrost facilities are additionally submitted for a defrost test in the most unfavourable conditions.

All appliances are operated continuously until steady conditions are achieved, except for defrost tests.

Appliances are operated under **normal operation** with flow rates which give the most unfavourable result.

NOTE 101 Consideration can be given to air or liquid flow rates, air or liquid temperatures, (air) static pressure, compressor operation conditions, etc.

11.8 During the test, the temperature rises are monitored continuously and shall not exceed the values shown in Table 3.

If the temperature rise of the motor winding exceeds the value specified in Table 3 or if there is doubt with regard to the temperature classification of the insulation of the motor, the tests of normative Annex C are carried out.

Protective devices shall not operate and sealing compound shall not flow out. However, components in **protective electronic circuits** are allowed to operate provided they are tested for the number of cycles of operation specified in 24.1.4.

Temperatures shall not exceed the temperature limit according to the following formula:

$$\text{Temperature limit } [^{\circ}\text{C}] = 25\text{ }^{\circ}\text{C} + \text{Table 3 value} \quad (101)$$

NOTE 101 Formula (101) calculates the temperature limit from the temperature rise as defined in Table 3.

Table 3 – Maximum normal temperature rises

Part	Temperature rise K
<i>Windings other than windings of sealed motor-compressors^a, if the winding insulation according to IEC 60085 is:</i> – class 105 (A) 75 (65) – class 120 (E) 90 (80) – class 130 (B) 95 (85) – class 155 (F) 115 – class 180 (H) 140 – class 200 (N) 160 – class 220 (R) 180 – class 250 210 <i>Pins of appliance inlets:</i> – for very hot conditions 130 – for hot conditions 95 – for cold conditions 45	
<i>Windings of sealed motor-compressors^{aa}</i> – with synthetic insulation 115 – with non-synthetic insulation 105	
<i>Duct and discharge plenum at points of specified zero clearance to test enclosure</i>	67
<i>Pins of appliances for insertion into socket-outlets, pins of plug connectors inserted into appliance outlets accessible to the user and plugs inserted into socket-outlets accessible to the user</i>	45
<i>Terminals, including earthing terminals and functional earthing terminals, for external conductors of stationary appliances, unless they are provided with a supply cord</i>	60
<i>Ambient of switches, thermostats and temperature limiters:^b</i> – without T-marking 30 – with T-marking T-25	
<i>Rubber, polychloroprene or polyvinyl chloride insulation of internal and external wiring, including supply cords:</i> – without temperature rating or with a temperature rating not exceeding 75 °C 50 – with temperature rating (T)ⁱ where T exceeds 75 °C T-25	
<i>Cord sheaths used as supplementary insulation</i>	35
<i>Sliding contacts of cord reels</i>	65
<i>Points where the insulation of wires can come into contact with parts of a terminal block or compartment for fixed wiring, for a stationary appliance not provided with a supply cord.</i>	50 ^c
<i>Rubber, other than synthetic, used for gaskets or other parts, the deterioration of which could affect safety:</i> – when used as supplementary insulation or as reinforced insulation 40 – in other cases 50	
<i>Lampholders with T-marking^d</i> – B15 and B22 marked T1 140 – B15 and B22 marked T2 185 – other lampholders T-25 <i>Lampholders without T-marking^d</i> – E14 and B15 110 – B22, E26 and E27 140 – other lampholders and starter holders for fluorescent lamps 55	

Part	Temperature rise K
Material used as insulation, other than that specified for wires and windings: ^e – impregnated or varnished textile, paper or press-board – laminates bonded with: • melamine-formaldehyde, phenol-formaldehyde or phenol-furfural resins • urea-formaldehyde resin – printed circuit boards bonded with epoxy resin – moulding of: • phenol-formaldehyde with cellulose fillers • phenol-formaldehyde with mineral fillers • melamine-formaldehyde • urea-formaldehyde – polyester with glass reinforcement – silicone rubber – polytetrafluoroethylene – pure mica and tightly sintered ceramic material when such materials are used as supplementary insulation or reinforced insulation – thermoplastic material ^f	70 85 (175) 65 (150) 120 85 (175) 100 (200) 75 (150) 65 (150) 110 145 265 400 –
Wood, in general ^g – Wooden supports, walls, ceiling and floor of the test corner and wooden cabinet: • stationary appliances liable to be operated continuously for long periods • other appliances	65 60 65
Outer surface of capacitors: ^h – with marking of maximum operating temperature (T): ⁱ – without marking of maximum operating temperature: • small ceramic capacitors for radio and television interference suppression • capacitors complying with IEC 60384-14:2013 including IEC 60384-14:2013/AMD1:2016 • other capacitors	T-25 50 50 20
External enclosure of motor-operated appliances except handles held in normal use: ^m – of bare metal – of coated metal ⁿ – of glass and ceramic – of plastic having a thickness exceeding 0,4 mm ^l	48 59 65 74
Surfaces of handles, knobs, grips and similar parts which are continuously held in normal use (e.g. soldering irons): ^m – of bare metal – of coated metal ⁿ – of porcelain or vitreous material – of rubber or of plastic having a thickness exceeding 0,4 mm ^l – of wood	30 34 40 50 50

Part	Temperature rise K
Surfaces of handles, knobs, grips and similar parts ^k which are held for short periods only in normal use (e.g. switches): ^m	
– of bare metal	35
– of coated metal ⁿ	39
– of porcelain or vitreous material	45
– of rubber or of plastic having a thickness exceeding 0,4 mm ^l	60
– of wood	65
Parts in contact with oil having a flash-point of t °C	t-50
NOTE 1 If other materials than those mentioned in the table are used, they are not to be subjected to temperatures in excess of their thermal capabilities as determined by ageing tests. NOTE 2 The values in the table are based on an ambient temperature not normally exceeding 25 °C but occasionally reaching 35 °C. However, the temperature rise values specified are based on 25 °C. Heat pumps, air-conditioners and other appliances covered by this standard can have other ambient temperature than normal household appliances, for example some products are used outdoors. NOTE 3 The temperature of the terminals of switches is measured if the switch is tested in accordance with normative Annex H.	
^a To allow for the fact that the average temperature of windings of universal motors, relays, solenoids and similar components is usually above the temperature at the points on the windings where thermocouples are placed, the figures without parentheses apply when the resistance method is used and those within parentheses apply when thermocouples are used. For windings of vibrator coils and AC motors, the figures without parentheses apply in both cases. The temperature rise limit of windings in transformers and inductors mounted on printed circuit boards is equal to the thermal class of the winding insulation reduced by 25 K provided the largest dimension of the winding does not exceed 5 mm in cross section or length. For motors constructed so that the circulation of air between the inside and the outside of the case is prevented but which are not necessarily sufficiently enclosed to be considered airtight, the temperature rise limits may be increased by 5 K. For hermetically sealed motors, the temperature rise limit may be increased by 8 K. ^b T means the maximum ambient temperature in which the component or its switch head can operate. The ambient is the temperature of the air at the hottest point at a distance of 5 mm from the surface of the component concerned. However, if a thermostat or a temperature limiter is mounted on a heat-conducting part, the declared temperature limit of the mounting surface (Ts) is also applicable. Therefore, the temperature rise of the mounting surface has to be measured. The temperature rise limit does not apply to switches or controls tested in accordance with the conditions occurring in the appliance. ^c This limit may be exceeded if the instruction specified in 7.12.3 is supplied. ^d Locations for measuring the temperature rises are specified in Table 12.1 of IEC 60598-1:2014 including IEC 60598-1:2014/AMD1:2017. ^e The values in parentheses apply to locations where the part is fixed to a hot surface. ^f There is no specific limit for thermoplastic material. However, the temperature rise has to be determined in order that the tests of 30.1 can be carried out. ^g The limit specified concerns the deterioration of wood and it does not take into account deterioration of surface finishes. ^h There is no limit for the temperature rise of capacitors that are short-circuited in 19.11. ⁱ Temperature marking for capacitors mounted on printed circuit boards may be given in the technical sheet.	

- j IEC 60245 Types 53 and 57 **supply cords** have a T rating of 60 °C;
 IEC 60245 Type 88 **supply cords** have a T rating of 70 °C;
 IEC 60227 Types 52 and 53 **supply cords** have a T rating of 70 °C;
 IEC 60227 Types 56 and 57 **supply cords** have a T rating of 90 °C;
 IEC 62821 Types 101 and 101f **supply cords** have a T rating of 70 °C;
 IEC 62821 Types 102 and 102f **supply cords** have a T rating of 70 °C.
- k The temperature rise limits of controls actuated by contact or proximity of a finger, with no movement of the contact surface also includes all surfaces within 5 mm of such controls, regardless of their shape.
- l The temperature rise limit of plastic also applies for plastic material having a metal finish of thickness less than 0,1 mm.
- m When the thickness of the plastic coating does not exceed 0,4 mm, the temperature rise limits of the coated metal or of glass and ceramic material apply.
- n Metal is considered coated when a coating having a minimum thickness of 90 µm made by enamel, powder or non-substantially plastic coating is used.
- aa Not required for motor-compressors that comply with IEC 60335-2-34:2021 (including its Annex AA).

12 Charging of metal-ion batteries

Charging a **battery** that uses metal-ion chemistry under **normal operation** shall not cause any **cell** to exceed its **specified operating region for charging**.

Compliance is checked using a **battery** that has been **fully discharged**, by charging the **battery**, with the **charging system** indicated in the instructions, at an ambient temperature of 20 °C ± 5 °C, irrespective of the minimum and maximum ambient temperatures for charging the **battery** specified in the instructions.

If the manufacturer's specified:

- minimum ambient temperature for charging the battery is less than 10 °C, the test is repeated at the specified minimum ambient temperature $\begin{smallmatrix} +0 \\ -5 \end{smallmatrix}$ °C;
- maximum ambient temperature for charging the battery is greater than 40 °C, the test is repeated at the specified maximum ambient temperature $\begin{smallmatrix} +5 \\ -0 \end{smallmatrix}$ °C.

For all individual **cells**, the voltage, the temperature and the charging current are monitored.

In the case of parallel configurations, analysis may be used to avoid measuring the individual branch currents. The result shall not exceed the **specified operating region for charging** (e.g. limits of voltage and current dependent on the temperature).

NOTE 1 The following are example results of such analysis:

The charging current for each branch of a parallel connection would not need to be monitored, if:

- the maximum deliverable current of the **charging system** did not exceed the maximum charging current of a single **cell**; or
- for **cells** with identical specifications, the maximum deliverable current of the **charging system** divided by the number of branches of parallel connections does not exceed the maximum charging current of a single **cell**.
 Currents measured during **battery** charging shall be the average current over a period of between 1 s and 5 s.

The location of thermocouples for each **cell** temperature measurement shall be on the outer surface, halfway along the longest dimension of the **cell**.

NOTE 2 A specially prepared **battery** can be used for this test.

For each **cell**, the **specified operating region for charging** specified by the **cell** manufacturer shall not be exceeded at the temperature of the **cell** (T_{cell}).

When the test is carried out at an ambient temperature of $20\text{ °C} \pm 5\text{ °C}$

- $T_{cell} = T_{meas} + (T_{amb(max)} - T_{amb(test)})$, for the maximum recommended ambient temperature for charging;
- $T_{cell} = T_{meas} - (T_{amb(test)} - T_{amb(min)})$, for the minimum recommended ambient temperature for charging.

When the test is carried out at the recommended ambient temperature for charging, $T_{cell} = T_{meas}$

where

- T_{meas} is the **cell** surface temperature measured during the test;
- T_{cell} is the **cell** surface temperature specified by the **cell** manufacturer;
- $T_{amb(max)}$ is the maximum ambient temperature for charging specified by the manufacturer;
- $T_{amb(min)}$ is the minimum ambient temperature for charging specified by the manufacturer;
- $T_{amb(test)}$ is the ambient temperature of the test room during the test.

For **batteries** where the **cells** are configured in series, the test is repeated with the charge in one **battery** deliberately imbalanced. The imbalance is introduced into a **battery** that is **fully discharged** by charging one **cell** to approximately 50 % of being **fully charged**.

If it can be demonstrated that an imbalance less than 50 % would actually occur in **normal operation**, then this lower imbalance may be used.

This may be demonstrated by operating the **battery** in cycles. Each cycle starts with the **battery fully discharged** then the **battery** is **fully charged**. The cycling is continued until the **battery** capacity has decreased to 80 % of its rated capacity. The imbalance at this decreased capacity is then used.

Use of a lower imbalance may also be demonstrated through evaluation of those designs that employ circuitry intended for maintaining balance between **cells** in the **battery**. **Batteries** with a small number of **cells** in series may be shown to exhibit limited imbalance in practice, if charging ceases with the **battery** prepared with a smaller initial imbalance.

13 Leakage current and electric strength at operating temperature

13.1 At operating temperature, the leakage current of the appliance shall not be excessive and its electric strength shall be adequate.

Compliance is checked by the tests of 13.2 and 13.3.

The appliance is operated under **normal operation** for the duration specified in 11.7.

Heating appliances are operated at 1,15 times the **rated power input**.

Motor-operated appliances and **combined appliances** are supplied at 1,06 times **rated voltage**.

Three-phase appliances, which according to the instructions for installation are also suitable for single-phase supply, are tested as single-phase appliances with the three circuits connected in parallel.

Protective impedance and radio interference filters are disconnected before carrying out the tests.

13.2 The leakage current is measured by means of the circuit described in Figure 4 of IEC 60990:2016. For **class 0I appliances** and **class I appliances**, except parts of **class II construction**, C may be replaced by a low impedance ammeter responding to the **rated frequency** of the appliance.

The leakage current is measured between any pole of the supply and:

- **accessible metal parts** intended to be connected to protective earth, for **class I appliances** and **class 0I appliances**;
- metal foil having an area not exceeding $20\text{ cm} \times 10\text{ cm}$ which is in contact with **accessible surfaces** of insulating materials and metal parts not intended to be connected to protective earth, for **class 0 appliances**, **class II appliances**, **class II constructions** and **class III appliances**.

The metal foil has the largest area possible on the surface under test without exceeding the dimensions specified. If its area is smaller than the surface under test, it is moved to test all parts of the surface. The heat dissipation of the appliance is not to be affected by the metal foil.

For single-phase appliances, the measuring circuit is shown in the following figures:

- if they are **class II appliances** or parts of **class II construction**, Figure 1;
- if they are neither **class II appliances** nor parts of **class II construction**, Figure 2.

The leakage current is measured with the selector switch in each of the positions a and b.

For three-phase with neutral (3N~) connected appliances, the measuring circuit is shown in the following figures:

- if they are **class II appliances** or parts of **class II construction**, Figure 3;
- if they are neither **class II appliances** nor parts of **class II construction**, Figure 4.

The leakage current is measured with the switches a, b and c in the closed position. The measurements are then repeated with each of the switches a, b and c open in turn, the other two switches remaining closed. For three-phase without neutral (3~) connected appliances, the measuring circuit in Figure 3 or Figure 4 shall be used as applicable, but the neutral is not connected to the appliance.

After the appliance has been operated for a duration as specified in 11.7, the leakage current shall not exceed the following values:

– for class II appliances and for parts of class II construction	0,35 mA peak
– for class 0 and class III appliances	0,7 mA peak
– for class 0I appliances	0,5 mA
– for portable class I appliances	0,75 mA
– for stationary class I motor-operated appliances	3,5 mA
– for stationary class I heating appliances	0,75 mA or 0,75 mA per kW rated power input of the appliance with a maximum of 5 mA, whichever is higher

Modification:

For stationary class I motor-operated appliances, the leakage current shall not exceed 3,5 mA, or 2 mA per kilowatt rated power input, whichever is higher. The maximum value shall not exceed 10 mA for appliances accessible to the general public and 30 mA for appliances not accessible to the general public.

For combined appliances, the total leakage current may be within the limits specified for heating appliances or motor-operated appliances, whichever is the greater, but the two limits are not added.

If the appliance incorporates capacitors and is provided with a single-pole switch, the measurements are repeated with the switch in the off position.

If the appliance incorporates a thermal control which operates during the test of Clause 11, the leakage current is measured immediately before the control opens the circuit.

NOTE The test with the switch in the **off position** is carried out to verify that capacitors connected behind a single-pole switch do not cause an excessive leakage current.

WARNING – In order to avoid an electric shock hazard, the appliance shall be supplied through an isolating transformer or it shall be insulated from earth.

13.3 The appliance is disconnected from the supply and the insulation is immediately subjected to a voltage having a frequency of 50 Hz or 60 Hz for 1 min, in accordance with IEC 61180.

The high-voltage source used for the test is to be capable of supplying a short circuit current I_s between the output terminals after the output voltage has been adjusted to the appropriate test voltage. The overload release of the circuit is not to be operated by any current below the tripping current I_r . The values of I_s and I_r are given in Table 5 for various high-voltage sources.

The test voltage is applied between **live parts** and **accessible parts**, non-metallic parts being covered with metal foil. For **class II constructions** having intermediate metal between **live parts** and **accessible parts**, the voltage is applied across the **basic insulation** and the **supplementary insulation**.

During the test, care shall be taken to avoid overstressing the components of **electronic circuits**.

The values of the test voltages are specified in Table 4.

Table 4 – Voltage for electric strength test

<i>Insulation</i>	<i>Test voltage</i>			
	<i>V</i>			
	<i>Rated voltage ^a</i>			<i>Working voltage (U)</i>
	<i>SELV</i>	<i>≤150 V</i>	<i>>150 V and ≤250 V ^b</i>	<i>>250 V</i>
Basic insulation	500	1 000	1 000	1,2 U + 700
Supplementary insulation		1 250	1 750	1,2 U + 1 450
Reinforced insulation		2 500	3 000	2,4 U + 2 400

^a For multi-phase appliances, the line to neutral or line to earth voltage is used for **rated voltage**. The test voltage for 480 V multi-phase appliances is that specified for a **rated voltage** in the range > 150 V and ≤ 250 V.

^b For appliances having a **rated voltage** ≤ 150 V, these test voltages apply to parts having a **working voltage** > 150 V ≤ 250 V.

No breakdown shall occur during the test.

Glow discharges without a drop in voltage are neglected.

Table 5 – Characteristics of high-voltage sources

<i>Test voltage</i>	<i>Minimum current</i>	
	<i>mA</i>	
<i>V</i>	<i>I_s</i>	<i>I_r</i>
≤ 4 000	200	100
> 4 000 and ≤ 10 000	80	40
> 10 000 and ≤ 20 000	40	20

NOTE The currents are calculated on the basis of the short circuit and release energies of 800 VA and 400 VA respectively at the upper end of the voltage ranges.

14 Transient overvoltages

Appliances shall withstand the transient over-voltages to which they may be subjected.

Compliance is checked by subjecting each **clearance** having a value less than those specified in Table 16 to an impulse voltage test.

The impulse test voltage has a no-load wave shape corresponding to the 1,2/50 µs standard impulse specified in IEC 61180. The impulse test voltage is applied three times for each polarity with intervals of at least 1 s.

The impulse test voltage is specified in Table 6 for **rated impulse voltages** given in Table 15.

Table 6 – Impulse test voltage

Rated impulse voltage	Impulse test voltage^a
V	V
330	357
500	540
800	930
1 500	1 750
2 500	2 920
4 000	4 920
6 000	7 380
8 000	9 840
10 000	12 300
^a The impulse test voltages have been calculated using correction factors for testing at locations situated at sea level. It is considered that they are appropriate for any location between sea level and 500 m. If tests are carried out at other locations, other correction factors shall be used as noted in Subclause 6.1.2.2.1.3 of IEC 60664-1:2007.	

There shall be no flashover. However, flashover of **functional insulation** is allowed if the appliance complies with Clause 19 when the **clearance** is short-circuited.

15 Moisture resistance

15.1 Electrical components of appliances shall be protected against the ingress of water which can be present in the appliance as a result of rain, overflow from the drain pan, or defrosting.

Compliance is checked by the tests of 15.2, followed immediately by the overflow test of 15.3; and this is followed by the defrost test of 11.7, and the tests of Clause 16.

Following these tests, an inspection is made within the enclosures. The water which can have entered the enclosure shall not have reduced **clearances** and **creepage distances** below the minimum values specified in Clause 29.

If ducts leading to the outside of a building are used, the test of 15.2 is carried out on the terminations of such ducts in an arrangement simulating the actual installation, according to the instructions.

For appliances intended to be mounted through a wall or a window, or for a split unit, the test of 15.2 is carried out on that part or unit which, according to the instructions, is intended to be mounted outside the building.

The motor-compressor is not operated and **detachable parts** are removed during the tests of 15.2 and 15.3.

15.2 Appliances other than IPX0 are subjected to the tests of IEC 60529:1989 as follows:

- IPX1 appliances as described in 14.2.1;
- IPX2 appliances as described in 14.2.2;
- IPX3 appliances as described in 14.2.3;
- IPX4 appliances as described in 14.2.4;
- IPX5 appliances as described in 14.2.5;

- IPX6 appliances as described in 14.2.6;
- IPX7 appliances as described in 14.2.7.

For the IPX7 test, the appliance is immersed in water containing 1 % NaCl.

15.3 The appliance is installed in its position of normal use. The drain pan discharge pipe is blocked, and the pan carefully filled to the brim without splashing. The drain pan is then subjected to a continuous overflow, the rate of which is adjusted to approximately 17 cm³/s per 1 m³/s airflow, and the fan(s) switched on. The test is continued for a period of 30 min, or until all water drains from the appliance.

15.101 Spillage testing of indoor floor or wall-mounted **appliances accessible to the general public** are tested as follows.

The appliance is installed according to the installation instructions but not operated.

Covers which provide access for manual operation of electrical controls are set in the open position, unless such covers are of the self-closing type.

A solution of 0,25 l of water containing approximately 1 % NaCl is poured onto the unit in a manner which is most likely to cause entrance of water into or on electrical controls or **uninsulated live parts**.

After spillage is completed, the appliances shall withstand the tests of Clause 16.

The spillage test is not applicable to units if the minimum linear dimension of a horizontal or near horizontal top surface of the cabinet is 75 mm or less.

A unit whose top, when installed, has a height of greater than 2 m need not be tested.

NOTE The intent is that a 75 mm diameter glass cannot be placed on the surface of the appliance and spill.

16 Leakage current and electric strength

16.1 The leakage current of the appliance shall not be excessive and its electric strength shall be adequate.

Compliance is checked by the tests of 16.2 and 16.3.

Protective impedance is disconnected from **live parts** before carrying out the tests.

The tests are carried out on the appliance at **room temperature** and not connected to the supply mains.

16.2 An AC test voltage is applied between **live parts** and:

- **accessible metal parts** intended to be connected to protective earth, for **class I appliances** and **class 0I appliances**;
- metal foil having an area not exceeding 20 cm × 10 cm which is in contact with **accessible surfaces** of insulating material and metal parts not intended to be connected to protective earth, for **class 0 appliances**, **class II appliances**, **class II constructions** and **class III appliances**.

The test voltage is:

- 1,06 times **rated voltage**, for single-phase appliances;

- 1,06 times **rated voltage**, divided by $\sqrt{3}$, for three-phase appliances.

The leakage current is measured within 5 s after the application of the test voltage.

The leakage current shall not exceed the following values:

- for **class II appliances** and for parts of **class II construction** 0,25 mA
- for **class 0, class 0I and class III appliances** 0,5 mA
- for **portable class I appliances** 0,75 mA
- for **stationary class I motor-operated appliances** 3,5 mA
- for **stationary class I heating appliances** 0,75 mA or 0,75 mA per kW **rated power input** of the appliance with a maximum of 5 mA, whichever is higher

Modification:

For **stationary class I motor-operated appliances**, the leakage current shall not exceed 3,5 mA, or 2 mA per kilowatt **rated power input**, whichever is higher. The maximum value shall not exceed 10 mA for **appliances accessible to the general public** and 30 mA for **appliances not accessible to the general public**.

The values specified above are doubled if all controls have an **off position** in all poles. They are also doubled if:

- the appliance has no control other than a **thermal cut-out**; or
- all **thermostats, temperature limiters** and energy regulators do not have an **off position**; or
- the appliance has radio interference filters. In this case, the leakage current with the filter disconnected shall not exceed the limits specified.

For **combined appliances**, the total leakage current may be within the limits specified for **heating appliances** or **motor-operated appliances**, whichever is the greater, but the two limits are not added.

For measuring the leakage current, a low impedance ammeter capable of measuring the true RMS value of current may be used.

16.3 Immediately after the test of 16.2, the insulation is subjected to a voltage having a frequency of 50 Hz or 60 Hz for 1 min in accordance with IEC 61180. The values of the test voltage for different types of insulation are given in Table 7.

Accessible parts of insulating material are covered with metal foil. Care is to be taken that the metal foil is placed so that no flashover occurs at the edges of the insulation.

Table 7 – Test voltages

Insulation	Test voltage V			
	Rated voltage ^a			Working voltage (U)
	SELV	≤150 V	>150 V and ≤250 V ^b	>250 V
Basic insulation ^c	500	1 250	1 250	1,2 U + 950
Supplementary insulation ^c	–	1 250	1 750	1,2 U + 1 450
Reinforced insulation	–	2 500	3 000	2,4 U + 2 400

^a For multi-phase appliances, the line to neutral or line to earth voltage is used for **rated voltage**. The test voltage for 480 V multi-phase appliances is that specified for a **rated voltage** in the range > 150 V and ≤ 250 V.

^b For appliances having a **rated voltage** ≤150 V, these test voltages apply to parts having a **working voltage** > 150 V and ≤ 250 V.

^c In constructions where **basic insulation** and **supplementary insulation** cannot be tested separately, the insulation is subjected to the test voltages specified for **reinforced insulation**.

A test voltage is applied between **accessible metal parts** and the **supply cord** which is wrapped with metal foil at the point where the **supply cord** is located in an inlet bushing and where, for appliances having a **type X attachment**, the **supply cord** is located in a cord guard or a cord anchorage with their clamping screws, if any, being tightened to two-thirds of the torque specified in Table 14. The test voltage is 1 250 V for **class 0 appliances** and **class I appliances** and 1 750 V for **class II appliances**.

During the test care shall be taken to avoid overstressing

- the components of **electronic circuits**;
- the **basic insulation** or the **supplementary insulation** when applying the voltage to **reinforced insulation** in **class II constructions** incorporating both **reinforced insulation** and **double insulation**.

NOTE 1 The characteristics of the high-voltage source used for the test are described in Table 5.

NOTE 2 When testing insulating coatings, the metal foil can be pressed against the insulation by means of a sandbag so that the pressure is approximately 5 kPa. The test can be limited to places where the insulation is likely to be weak, for example where there are sharp metal edges under the insulation.

NOTE 3 If practicable, insulating linings can be tested separately.

No breakdown shall occur during the test.

Glow discharges without a drop in voltage are neglected.

17 Overload protection of transformers and associated circuits

Appliances incorporating circuits supplied from a transformer shall be constructed so that in the event of short circuits which are likely to occur in normal use, excessive temperatures do not occur in the transformer or in the circuits associated with the transformer.

NOTE Examples are the short-circuiting of bare or inadequately insulated conductors of **accessible circuits** operating at **safety extra-low voltage**.

Compliance is checked by applying the most unfavourable short circuit or overload which is likely to occur in normal use, the appliance being supplied with 1,06 times or 0,94 times **rated voltage**, whichever is the more unfavourable. **Basic insulation** is not short circuited.

*The temperature rise of the insulation of the conductors of **safety extra-low voltage** circuits shall not exceed the relevant value specified in Table 3 by more than 15 K.*

The temperature of windings shall not exceed the values specified in Table 8. However, these limits do not apply to fail-safe transformers complying with Subclause 15.5 of IEC 61558-1:2017.

18 Endurance

This clause of Part 1 is not applicable.

19 Abnormal operation

19.1 Appliances shall be constructed so that as a result of abnormal or careless operation, the risk of fire, mechanical damage impairing safety or protection against electric shock is obviated as far as is practicable.

Electronic circuits shall be designed and applied so that a fault condition will not render the appliance unsafe with regard to electric shock, fire hazard, mechanical hazard or **dangerous malfunction**.

Failure of the transfer medium flow, or of any control devices, shall not result in a hazard.

Appliances are subjected to the tests specified in 19.2 to 19.10, 19.101, 19.102, 19.103, and 19.104 as applicable.

*Appliances incorporating **electronic circuits** are subjected to the tests of 19.11 and 19.12, as applicable.*

Appliances incorporating contactors or relays are subjected to the test of 19.14.

Appliances incorporating voltage selector switches are subjected to the test of 19.15.

*Appliances having a mains connection and **batteries** that are replaceable are subjected to the test of 19.16.*

*Appliances incorporating **batteries** that are rechargeable and use metal-ion chemistries are subjected to the test of 19.17.*

*Unless otherwise specified, the tests are continued until a **non-self-resetting thermal cut-out** operates or until steady conditions are established. If a heating element or an **intentionally weak part** becomes permanently open-circuited, the relevant test is repeated on a second sample. That same part on the second sample shall also become permanently open-circuited in the second test, unless a **non-self-resetting thermal cut-out** operates or steady conditions are established.*

NOTE Fuses, **thermal cut-outs**, overcurrent protection devices, or similar devices incorporated in the appliance, can be used to provide the necessary protection. The **protective device** in the fixed wiring does not provide the necessary protection.

Unless otherwise specified, only one abnormal condition is simulated at any one time.

*If more than one of the tests are applicable to the same appliance, these tests are carried out consecutively after the appliance has cooled down to **room temperature**.*

For **combined appliances**, the tests are carried out with motors and heating elements operating simultaneously under **normal operation**, the appropriate tests being applied one at a time to each motor and heating element.

When it is stated that a control is short-circuited, it may be rendered inoperative instead. If the control performs more than one function, only that aspect of the control under consideration is rendered inoperative. Other functions of the control may continue to operate normally.

Unless otherwise specified, compliance with the tests of this clause is checked as described in 19.13.

19.2 Appliances with heating elements are tested under the conditions specified in Clause 11 but with restricted heat dissipation. The supply voltage, determined prior to the test, is that required to provide a power input of 0,85 times **rated power input** under **normal operation** when the power input has stabilized. This voltage is maintained throughout the test.

NOTE Controls that operate during the test of Clause 11 are allowed to operate.

*This subclause of Part 1 is not applicable for appliances with **supplementary air heaters**.*

19.3 The test of 19.2 is repeated but with a supply voltage, determined prior to the test, equal to that required to provide a power input of 1,24 times **rated power input** under **normal operation** when the power input has stabilized. This voltage is maintained throughout the test.

NOTE Controls that operate during the test of Clause 11 are allowed to operate.

*This subclause of Part 1 is not applicable for appliances with **supplementary air heaters**.*

19.4 The appliance is tested under the conditions specified in Clause 11. Any control that limits the temperature during the test of Clause 11 is short-circuited.

If the appliance incorporates more than one control, they are short-circuited in turn.

The appliance is operated under the conditions in Clause 11 and at **rated voltage**, with any form of operation or any defect that can be expected during normal use. Only one fault condition is reproduced at a time, the tests being made consecutively.

Examples of fault conditions are

- the timer, if any, stopping in any position;
- disconnection and reconnection of one or more phases of the supply;
- open-circuiting or short-circuiting of components, like relays, contactors, timers, **thermostats**, etc.

In general, tests are limited to those cases which are expected to give the most unfavourable results.

19.5 The test of 19.4 is repeated on **class 0I appliances** and **class I appliances** incorporating tubular sheathed or embedded heating elements. However, controls are not short-circuited but one end of the element is connected to the sheath of the heating element.

A control that operates during this test and the test of Clause 11 and that incorporates an **electronic circuit** is not considered to be a **protective electronic circuit** if the appliance complies with 19.13 with the electronic control rendered inoperative.

This test is repeated with the polarity of the supply to the appliance reversed and with the other end of the element connected to the sheath.

The test is not carried out on appliances:

- *intended to be permanently connected to fixed wiring;*
- *where an **all-pole disconnection** occurs during the test of 19.4; or*
- *used in a system with polarized plugs intended for connection to polarized socket outlets.*

Appliances with a neutral are tested with the neutral connected to the sheath.

NOTE For embedded heating elements, the metal enclosure is considered to be the sheath.

19.6 Appliances with **PTC heating elements** are supplied at **rated voltage** until steady conditions with regard to power input and temperature are established.

The **working voltage** of the **PTC heating element** is increased by 5 % and the appliance is operated until steady conditions are re-established. The voltage is then increased in similar steps until 1,5 times **working voltage** is reached, or until the **PTC heating element** ruptures, whichever occurs first.

19.7 The motors, other than motor-compressors and stationary circulation pumps in compliance with IEC 60335-2-51, are mounted on a support of wood or similar material. The motor rotors are locked; fan blades and brackets are not removed.

The motors are supplied at their supplied voltage when the appliance is supplied at **rated voltage** or at the upper limit of the **rated voltage range** in a circuit as shown in Figure 103. Care shall be taken to complete the earthing system to permit the correct operation of the RCCB/RCBO.

Under these conditions, the motor is operated for 15 days (360 h) or until a **protection device** permanently opens the circuit, whichever is the shorter period.

During the test, the ambient temperature is maintained at $23\text{ °C} \pm 5\text{ °C}$.

If the temperature of the motor windings does not exceed 90 °C when steady conditions are established, the test is considered to be ended.

During the test, the temperature of the enclosure shall not exceed 150 °C and the temperature of the windings shall not exceed the values shown in Table 8.

Three days (72 h) after the beginning of the test, the motor shall withstand an electric strength test as specified in 16.3.

At the end of the test, the leakage current, when measured as specified in 16.2 but with a test voltage of twice the **rated voltage** between all windings and the enclosure, shall not exceed 2 mA.

NOTE 101 Only for this test specified in 19.7 of this standard, the motor is locked and operated for 15 days (360 h) or until a protection device permanently opens the circuit. It is not the intention to repeat the 15-day locked rotor test up to two more times for motors having capacitors in the circuit of an auxiliary winding. Hence for all tests according to 19.7 of Part 1, the motor is operated under the conditions specified in 19.7 of Part 1, including the time specifications.

If an appliance has more than one motor, the test is carried out for each motor separately.

Appliances incorporating motors and having capacitors in the circuit of an auxiliary winding, are operated with the rotor locked, the capacitors being open-circuited one at a time. The test is repeated with the capacitors short-circuited one at a time, unless they are of class S2 or S3 of IEC 60252-1:2010 including IEC 60252-1:2010/AMD1:2013.

NOTE 1 This test is carried out with the rotor locked since some motors can start thus giving rise to inconsistent results.

For each of the tests, appliances provided with a timer or programmer are supplied at **rated voltage** for a period equal to the maximum period allowed by the timer or programmer. If the timer or programmer is an electronic type that operates to ensure compliance with the test before the maximum period under the conditions of Clause 11 is reached, it is considered to be a **protective electronic circuit** as well as a control that operates under the conditions of Clause 11.

Other appliances are supplied at **rated voltage** for a period:

- of 30 s for
 - **hand-held appliances;**
 - appliances that have to be kept switched on by hand or foot; and
 - appliances that are continuously loaded by hand.
- of 5 min for other appliances that are operated while attended;
- until steady conditions are established, for other appliances.

NOTE 2 Appliances that are tested for 5 min are indicated in the relevant part 2.

During the test, the temperature of the windings shall not exceed the relevant value specified in Table 8.

If the motor-compressor has not been type-tested against the requirements of IEC 60335-2-34, then it shall be subject to the following test.

A sample shall be provided with the rotor locked and being filled with oil and refrigerant as intended. The sample shall then be subjected to the tests specified in 19.101, 19.102, 19.103 and 19.105 of IEC 60335-2-34:2021, if applicable, and shall comply with the requirements in 19.104 of IEC 60335-2-34:2021.

Table 8 – Maximum winding temperature

Type of appliance	Temperature							
	°C							
	Class 105 (A)	Class 120 (E)	Class 130 (B)	Class 155 (F)	Class 180 (H)	Class 200 (N)	Class 220 (R)	Class 250
Appliances other than those operated until steady conditions are established	200	215	225	240	260	280	300	330
Appliances operated until steady conditions are established								
– if impedance protected	150	165	175	190	210	230	250	280
– if protected by a protective device								
• during the first hour, maximum value	200	215	225	240	260	280	300	330
• after the first hour, maximum value	175	190	200	215	235	255	275	305
• after the first hour, arithmetic average	150	165	175	190	210	230	250	280

19.8 Three phase motors other than motor-compressors are operated under the conditions of Clause 11 at **rated voltage** or at the upper limit of the **rated voltage range** with one phase disconnected, until steady conditions are obtained or the **protective device** operates.

19.9 This subclause of Part 1 is not applicable for motor-compressors, stationary circulation pumps in compliance with IEC 60335-2-51, and fans.

A running overload test is carried out on appliances incorporating motors that are intended to be remotely or automatically controlled or liable to be operated continuously.

Motor-operated appliances and **combined appliances** for which Subclause 30.23 is applicable and that use overload **protective devices** relying on **electronic circuits** to protect the motor windings, other than those that sense winding temperatures directly, are also subjected to the running overload test.

The appliance is operated under **normal operation** and supplied at **rated voltage** until steady conditions are established. The load is then increased so that the current through the motor windings is raised by 10 % and the appliance is operated again until steady conditions are established, the supply voltage being maintained at its original value. The load is again increased and the test is repeated until the **protective device** operates or the motor stalls.

During the test, the winding temperature shall not exceed:

- 140 °C, for class 105 (A) winding insulation;
- 155 °C, for class 120 (E) winding insulation;
- 165 °C, for class 130 (B) winding insulation;
- 180 °C, for class 155 (F) winding insulation;
- 200 °C, for class 180 (H) winding insulation;
- 220 °C, for class 200 (N) winding insulation;
- 240 °C, for class 220 (R) winding insulation;
- 270 °C, for class 250 winding insulation.

NOTE If the load cannot be increased in appropriate steps, the motor can be removed from the appliance and tested separately.

19.10 Appliances incorporating series motors are operated with the lowest possible load and supplied at 1,3 times **rated voltage** for 1 min.

During the test, parts shall not be ejected from the appliance.

19.11 Electronic circuits are checked by evaluation of the fault conditions specified in 19.11.2 for all circuits or parts of circuits, unless they comply with the conditions specified in 19.11.1.

NOTE 1 In general, examination of the appliance and its circuit diagram will reveal the fault conditions which have to be simulated, so that testing can be limited to those cases that can be expected to give the most unfavourable results.

Appliances incorporating an **electronic circuit** that relies upon a programmable component to function correctly are subjected to the test of 19.11.4.8, unless restarting at any point in the operating cycle after interruption of operation due to a supply voltage dip will not result in a hazard. The test is carried out after removal of all **batteries** and other components intended to maintain the programmable component supply voltage during mains supply voltage dips, interruptions and variations.

Appliances having a device with an **off position** obtained by electronic disconnection, or a device that can place the appliance in a stand-by mode, are subjected to the tests of 19.11.4.

NOTE 2 For information on general guidance relating to the sequence of tests for the evaluation of **electronic circuits**, reference can be made to informative Annex Q. It should be realized that in the Parts 2 there can be additional or alternative abnormal operation tests specified; these are not shown in the flow chart. For correct application of this standard, the normative text takes precedence over the guidance given in informative Annex Q.

If the safety of the appliance under any of the fault conditions depends on the operation of a miniature fuse-link complying with IEC 60127, the test of 19.12 is carried out.

*During and after each test, the temperature of windings shall not exceed the values specified in Table 8. However, these limits do not apply to fail-safe transformers complying with Subclause 15.5 of IEC 61558-1:2017. The appliance shall comply with the conditions specified in 19.13. Any current flowing through **protective impedance** shall not exceed the limits specified in 8.1.4.*

NOTE 3 Unless it is necessary to replace components after any of the tests, the electric strength test required by 19.13 need only be carried out after the final test on the **electronic circuit**.

If a conductor of a printed circuit board becomes open-circuited, the appliance is considered to have withstood the particular test, provided both of the following conditions are met:

- *the base material of the printed circuit board withstands the test of normative Annex E;*
- *any loosened conductor does not reduce **clearances** or **creepage distances** between **live parts** and **accessible metal parts** below the values specified in Clause 29.*

19.11.1 *Fault conditions a) to g) specified in 19.11.2 are not applied to circuits or parts of circuits when both of the following conditions are met:*

- *the **electronic circuit** is a low-power circuit as described below;*
- *protection against electric shock, fire hazard, mechanical hazard or **dangerous malfunction** of other parts of the appliance does not rely on the correct functioning of the **electronic circuit**.*

An example of a low-power circuit is shown in Figure 6 and is determined as follows.

*The appliance is supplied at **rated voltage** and a variable resistor, adjusted to its maximum resistance, is connected between the point to be investigated and the opposite pole of the supply source. The resistance is then decreased until the power consumed by the resistor reaches a maximum. Points closest to the supply source at which the maximum power delivered to this resistor does not exceed 15 W at the end of 5 s are called low-power points. The part of the circuit farther from the supply source than a low-power point is considered to be a low-power circuit.*

The measurements shall be made from only one pole of the supply source, preferably the one that gives the fewest low-power points. The power consumed by the variable resistor shall be measured by a wattmeter.

When determining the low-power points, it is recommended to start with points close to the supply source.

19.11.2 *The following fault conditions are considered and, if necessary, applied one at a time, consequential faults being taken into consideration:*

- a) *short circuit of **functional insulation** if **clearances** or **creepage distances** are less than the values specified in Clause 29;*
- b) *open circuit at the terminals of any component;*
- c) *short circuit of capacitors, unless they comply with IEC 60384-14:2013 including IEC 60384-14:2013/AMD1:2016;*
- d) *short circuit of any two terminals of an **electronic component**, other than an integrated circuit. This fault condition is not applied between the two circuits of an optocoupler;*

- e) *failure of triacs in the diode mode;*
- f) *failure of microprocessors and integrated circuits except components such as thyristors and triacs. All possible output signals are considered for faults occurring within the component. If it can be shown that a particular output signal is unlikely to occur, then the relevant fault is not considered;*
- g) *failure of an electronic power switching device in a partial turn-on mode with loss of gate (base) control.*

NOTE 1 This mode can be simulated by disconnecting the electronic power switching device gate (base) terminal and connecting an external adjustable power supply between the gate (base) terminal and the source (emitter) terminal of the electronic power switching device. The power supply is then varied so as to achieve a current that will not damage the electronic power switching device but will give the most onerous conditions of test.

NOTE 2 Examples of electronic power switching devices are field effect transistors (FET's and MOSFET's) and bipolar transistors (including IGBT's).

Fault condition f) is applied to encapsulated and similar components if the circuit cannot be assessed by other methods.

Positive temperature coefficient resistors are not short-circuited if they are used within the manufacturer's specification. However, PTC-S thermistors are short-circuited unless they comply with IEC 60738-1.

In addition, each low-power circuit is short-circuited by connecting the low-power point to the pole of the supply source from which the measurements were made.

*Any cord provided between a **battery-operated appliance** that consumes more than 15 W and the **detachable power supply part** shall be short-circuited at the point along its length likely to produce the most adverse effects.*

*For simulation of the fault conditions, the appliance is operated under the conditions specified in Clause 11 but supplied at **rated voltage**.*

When any of the fault conditions are simulated, the duration of the test is:

- *as specified in 11.7 but only for one operating cycle and only if the fault cannot be recognized by the user, for example, a change in temperature;*
- *as specified in 19.7, if the fault can be recognized by the user, for example, when the motor of a kitchen machine stops;*
- *until steady conditions are established, for circuits continuously connected to the supply mains, for example, stand-by circuits.*

In each case, the test is ended if a non-self-resetting interruption of the supply occurs within the appliance.

19.11.3 *If the appliance incorporates a **protective electronic circuit** that operates to ensure compliance with Clause 19, the appliance is tested as follows:*

*A fault as indicated in a) to g) of 19.11.2 shall be incorporated in the **protective electronic circuit** either before the appliance is started or at any point in time after the appliance is started so that the most unfavourable conditions of the test are applied.*

*If the appliance is able to operate after the fault in the **protective electronic circuit** is incorporated, then the appliance is further tested as follows.*

For appliances for continuous operation the appliance is operated until steady conditions are reached. Then the relevant test of Clause 19 is repeated.

Other appliances are operated for one cycle of operation. Then the relevant test of Clause 19 is repeated.

Compliance is checked as specified in 19.13.

19.11.4 *The first paragraph of Part 1 is not applicable if unintentional operation does not cause any hazards.*

*Appliances having a device with an **off position** obtained by electronic disconnection, or a device that can be placed in the stand-by mode, are subjected to the tests of 19.11.4.1 to 19.11.4.7. The tests are carried out with the appliance supplied at **rated voltage**, the device being set in the **off position** or in the stand-by mode.*

*Appliances incorporating a **protective electronic circuit** are subjected to the tests of 19.11.4.1 to 19.11.4.7. The tests are carried out after the **protective electronic circuit** has operated during the relevant tests of Clause 19, except 19.2, 19.6, 19.11.3, 19.102 and 19.103.*

*If the appliance incorporates more than one **protective electronic circuit**, each **protective electronic circuit** shall be tested individually with the appliance operated under **normal operation** at any temperature within the working range.*

*It is not necessary for a component protected by a **protective electronic circuit** that has been previously tested and shown to comply with the requirements of 19.11.4 of its standard to be retested in the final application.*

NOTE 101 Components can be for example motor-compressors, fans and circulating pumps.

NOTE 102 Test results of 19.11.4.1, 19.11.4.2 and 19.11.4.3 can possibly be influenced by the wiring and the metal housing of the final application. Therefore, the best moment to perform these tests is once in the final application.

NOTE 103 **Protective electronic circuit** (PEC) operation is understood as the operation that stops the component(s) operation controlled by the PEC with the intention to prevent the hazardous situation.

*The tests are carried out with surge **protective devices** disconnected, unless they incorporate spark gaps.*

If the appliance has several modes of operation, the tests are carried out with the appliance operating in each mode, if necessary.

NOTE Appliances incorporating electronic controls complying with the IEC 60730 series of standards are not exempt from the tests.

For these tests, it can be necessary to provide specially prepared component samples, e.g. compressors with locked rotor.

19.11.4.1 *The appliance is subjected to electrostatic discharges in accordance with IEC 61000-4-2, test level 4 being applicable. Ten discharges having a positive polarity and ten discharges having a negative polarity are applied at each preselected point.*

19.11.4.2 *The appliance is subjected to radiated fields in accordance with IEC 61000-4-3.*

The frequency ranges tested shall be:

- 80 MHz to 1 000 MHz, test level 3;
- 1,4 GHz to 2,0 GHz, test level 3;
- 2,0 GHz to 2,7 GHz, test level 2.

*The dwell time for each frequency is to be sufficient to observe a possible malfunction of the protective **electronic circuit**.*

19.11.4.3 The appliance is subjected to fast transient bursts in accordance with IEC 61000-4-4. Test level 3 with a repetition rate of 5 kHz is applicable for signal and control lines. Test level 4 with a repetition rate of 5 kHz is applicable for the power supply lines. The bursts are applied for 2 min with a positive polarity and for 2 min with a negative polarity.

19.11.4.4 The power supply terminals of the appliance are subjected to voltage surges in accordance with IEC 61000-4-5, five positive impulses and five negative impulses being applied at the selected points. An open circuit test voltage of 2 kV is applicable for the line-to-line coupling mode, a generator having a source impedance of 2 Ω being used. An open circuit test voltage of 4 kV is applicable for the line-to-earth coupling mode, a generator having a source impedance of 12 Ω being used.

Earthed heating elements in **class I appliances** are disconnected during this test.

NOTE If a feedback system depends on inputs related to a disconnected heating element, an artificial network can be needed.

For appliances having surge arresters incorporating spark gaps, the test is repeated at a level that is 95 % of the flashover voltage.

19.11.4.5 The appliance is subjected to injected currents in accordance with IEC 61000-4-6, test level 3 being applicable. During the test, all frequencies between 0,15 MHz to 80 MHz are covered.

The dwell time for each frequency is to be sufficient to observe a possible malfunction of the **protective electronic circuit**.

19.11.4.6 For appliances having a **rated current** not exceeding 16 A, the appliance is subjected to the class 3 voltage dips and interruptions in accordance with IEC 61000-4-11:2020. The values specified in Table 1 and Table 2 of IEC 61000-4-11:2020 are applied at zero crossing of the supply voltage.

For appliances having a **rated current** exceeding 16 A, the appliance is subjected to the class 3 voltage dips and interruptions in accordance with IEC 61000-4-34:2005 including IEC 61000-4-34:2005/AMD1:2009. The values specified in Table 1 and Table 2 of IEC 61000-4-34:2005 including IEC 61000-4-34:2005/AMD1:2009 are applied at zero crossing of the supply voltage.

19.11.4.7 The appliance is subjected to mains signals in accordance with IEC 61000-4-13:2002 including IEC 61000-4-13:2002/AMD1:2009 and IEC 61000-4-13:2002/AMD2:2015, Table 11 with test level class 2 using the frequency steps according to Table 10.

19.11.4.8 The appliance is supplied at **rated voltage** and operated under **normal operation**. After approximately 60 s, the power supply voltage is reduced to a level such that the appliance ceases to respond to user inputs or parts controlled by the programmable component cease to operate, whichever occurs first at any temperature within the working range. This value of supply voltage is recorded. The appliance is supplied at **rated voltage** and operated under **normal operation**. The voltage is then reduced to a value of approximately 10 % less than the recorded voltage. It is held at this value for approximately 60 s and then increased to **rated voltage**. The rate of decrease and increase of the power supply voltage is to be approximately 10 V/s.

The appliance shall continue to either operate normally from the same point in its operating cycle at which the voltage decrease occurred or a manual operation shall be required to restart it.

19.12 If safety of the appliance depends upon the operation of a miniature fuse-link complying with IEC 60127 during any of the fault conditions specified in 19.11.2, the test is repeated but with the miniature fuse-link replaced by an ammeter. If the current measured:

- does not exceed 2,1 times the current rating of the fuse-link, the circuit is not considered to be adequately protected and the test is carried out with the fuse-link short-circuited;
- is at least 2,75 times the current rating of the fuse-link, the circuit is considered to be adequately protected;
- is between 2,1 times and 2,75 times the current rating of the fuse-link, the fuse link is short-circuited and the test is carried out
 - for the relevant period or for 30 min, whichever is the shorter, for quick acting fuse-links;
 - for the relevant period or for 2 min, whichever is the shorter, for time lag fuse-links.

In case of doubt, the maximum resistance of the fuse-link shall be taken into account when determining the current.

NOTE 1 The verification whether the fuse-link acts as a **protective device** is based on the fusing characteristics specified in IEC 60127, which also gives the information necessary to calculate the maximum resistance of the fuse-link.

NOTE 2 Other fuses are considered to be **intentionally weak parts** in accordance with 19.1.

19.13 During the tests, the appliance shall not emit flames, molten metal, or poisonous or ignitable gas in hazardous amounts and temperature rises shall not exceed the values shown in Table 9.

After the tests, and when the appliance has cooled to approximately **room temperature**, compliance with Clause 8 shall not be impaired and the appliance shall comply with 20.2 if it can still be operated.

Table 9 – Maximum abnormal temperature rise

Part	Temperature rise K
Wooden supports, walls, ceiling and floor of the test corner and wooden cabinets ^a	150
Insulation of the supply cord ^a without T marking, or with T marking up to 75 °C	150
Insulation of the supply cord ^a with T marking above 75 °C	T+75
Supplementary insulation and reinforced insulation other than thermoplastic materials ^b	1,5 times the relevant value specified in Table 3
Surfaces of product, discharge plenum, and duct at points of specified zero clearance to test casing	150
Surfaces of test casing where clearance more than zero to combustible material is specified	150
^a not applicable.	
^b There is no specific limit for supplementary insulation and reinforced insulation of thermoplastic material. However, the temperature rise has to be determined so that the test of 30.1 can be carried out.	

When the insulation, other than that of **class III appliances** or **class III constructions** that do not contain **live parts**, has cooled down to approximately **room temperature**, it shall withstand the electric strength test of 16.3, the test voltage, however, being as specified in Table 4.

The humidity treatment of 15.3 is not applied before this electric strength test.

For appliances which are immersed in or filled with conducting liquid in normal use, the appliance is immersed in or filled with water for 24 h before the electric strength test is carried out.

After the operation or interruption of a control, **clearances** and **creepage distances** across the **functional insulation** shall withstand the electric strength test of 16.3, the test voltage, however, being twice the **working voltage**.

The appliance shall not undergo a **dangerous malfunction**, and there shall be no failure of **protective electronic circuits** if the appliance is still operable.

During and after the tests, the no-load output voltage of an **accessible safety extra-low voltage** outlet or connector or Universal Serial Bus (USB) outlet shall not have increased by more than 3 V or 10 % of its no-load output voltage in normal use, whichever is higher, with a maximum of 42,4 V for DC and a peak value of 42,4 V for AC.

Appliances tested with an electronic switch in the **off position**, or in the stand-by mode, shall:

- not become operational; or
- if they become operational, not result in a **dangerous malfunction** during or after the tests of 19.11.4.

NOTE Unintended operation that could impair safety can result from careless use of appliances, such as:

- storage of small appliances while connected to the supply;
- placing flammable material on working surfaces of **heating appliances**; or
- placing objects in areas near motorized appliances that are not expected to start.

In an appliance containing lids or doors that are controlled by one or more interlocks, one of the interlocks may be released provided that both of the following conditions are fulfilled:

- the lid or door does not move automatically to an open position when the interlock is released;
- the appliance will not restart after the cycle in which the interlock was released.

19.14 Appliances are operated under the conditions of Clause 11. Any contactor or relay contact that operates under the conditions of Clause 11 is short-circuited.

If a relay or contactor with more than one contact is used, all contacts are short-circuited at the same time.

Any relay or contactor which operates only in order to ensure that the appliance is energized for normal use and that does not otherwise operate in normal use is not short-circuited.

If more than one relay or contactor operates in Clause 11, each such relay or contactor is short-circuited in turn.

Locking in the "on" position of the main contacts of a contact intended for switching on and off the heating element(s) in normal use is considered to be a fault condition, unless the appliance is provided with at least two sets of contacts connected in series. For example, by providing two contactors operating independently of each other or by providing one contactor having two independent armatures operating two independent sets of main contacts.

If the appliance has several modes of operation, the tests are carried out with the appliance operating in each mode, if necessary.

19.15 For appliances incorporating a mains voltage selector switch, this switch is set to the lowest **rated voltage** position and the highest value of **rated voltage** is applied.

19.16 Appliances having mains connection and **batteries** that are replaceable by the user are supplied at **rated voltage** and operated under **normal operation** but with the **batteries** removed or in any position allowed by the construction.

NOTE The intent is to determine that safe operation does not depend upon the presence of a **battery** voltage.

19.17 Battery-operated appliances incorporating a **battery** that uses metal-ion chemistry, the **charging system** and **battery** are checked by the following tests.

The **battery system** is operated as specified in the appliance manufacturer's instructions under the abnormal conditions listed below in a) to d). Each test is conducted until the test sample returns to **room temperature**, for at least 7 h or until twice the normal charge period has elapsed, whichever is longer.

a) the state of the **battery** is as follows:

- a series configured **battery** shall have a deliberate imbalance. The imbalance is introduced into a **battery** that has been **fully discharged** by charging one **cell** to the percentage of being **fully charged** applied during the test of Clause 12;
- a single **cell** or parallel only configuration **battery** shall be **fully discharged**.

b) If the test of Clause 12 is conducted with an imbalance of less than 50 % due to the function of circuitry intended for maintaining balance between **cells** in the **battery** and if a single fault of any component within that circuitry is shown to result in the loss of that function, then a series configured **battery** shall be **fully charged** with a deliberate imbalance. The imbalance is introduced into a **battery** that has been **fully discharged** by charging one **cell** to approximately 50 % of being **fully charged**.

c) For a **battery** with a series configuration, all **cells** are at approximately 50 % of being **fully charged**, except for one which is shorted. The **battery** is then **fully charged**.

d) With a **battery** that is **fully charged** connected to the **charging system**, a short circuit is introduced to the **charging system** across a component or between adjacent printed circuit tracks at a location expected to produce the most unfavourable results to evaluate the effect of back-feed from the **battery**. In addition, for a **charging system** with a cord that connects to the **battery**, the short circuit shall be introduced at the point likely to produce the most adverse effects. The resistance of the short circuit shall not exceed 10 mΩ.

No explosion or ignition of the **battery** shall occur during or after the test. However, **venting** of the **cells** is permitted provided that they have not vented by any means other than through their vents.

The voltage on any **cell** shall not exceed the **upper limit charging voltage** by more than 150 mV unless the **charging system** is permanently disabled from recharging the **battery**.

To determine if recharging is permanently disabled, the **battery** shall be discharged to approximately 50 % of being **fully charged**, by using the **battery-operated appliance** tested (in the case of an **integral battery**) or by using a new sample of the **battery-operated appliance** (in the case of a **detachable battery** and **separable battery**). An attempt is then made to recharge the **battery** normally. There shall be no charging current after 10 min or after 25 % of the nominal capacity has been delivered, whichever occurs first.

19.101 The appliance is operated under the conditions in Clause 11 at **rated voltage** or at the upper limit of the **rated voltage range**, at an ambient temperature of 23 °C ± 5 °C. When steady conditions are attained, the heat transfer medium flow of the **outdoor heat exchanger** is restricted or shut off, whichever is the most unfavourable without the appliance being non-operative.

After this test, **protective devices** that have operated are reset, and the test is repeated, with the heat transfer medium flow, fluid or air, of the **indoor heat exchanger**, restricted or shut off, whichever is the most unfavourable without the appliance being non-operative. In the case of appliances with defrosting systems, the heat transfer medium flow rate is additionally shut off at the beginning of the defrosting phase.

Appliances incorporating a motor common to both the **indoor heat exchangers** and **outdoor heat exchangers** are subjected to the above test, the motor being disconnected once steady conditions are attained.

19.102 The **indoor heat exchanger** of appliances using water as a heat transfer medium is subjected to the following test.

The appliance is operated under the conditions specified for Clause 10 at **rated voltage** or at the upper limit of the **rated voltage range** at the maximum water temperature specified by the manufacturer. The indoor water temperature shall be raised 15 K at a rate of 2 K/min and this temperature maintained for 30 min, after which the water temperature is lowered to its original value at the same rate.

19.103 Air to air appliances are operated under the conditions specified in Clause 11.

The **dry-bulb temperature** is then reduced to a value 5 K below the minimum value specified by the manufacturer.

The test is repeated except that the **dry-bulb temperature** is increased to a value 10 K above the maximum temperature specified by the manufacturer, but not to exceed 55 °C.

The appliances are operated at **rated voltage** or at the upper limit of the **rated voltage range**.

19.104 For appliances with **supplementary air heaters**:

19.104.1 General

Appliances provided with **supplementary air heaters** or provisions for **supplementary air heaters** are subjected to the test of 19.104.2 through 19.104.8 under the conditions specified in Clause 11 unless otherwise indicated.

All appliances with **supplementary air heaters** shall be configured with inlet and outlet ducts as applicable and instrumented in accordance with the applicable subclauses of Clause 11.

Appliances are tested in the **operating state** and configuration which give the most unfavourable results.

Appliances are operated at an ambient temperature of 23 °C ± 5 °C and **rated voltage** or at the upper limit of the **rated voltage range** of the **supplementary air heaters**.

Tests shall be conducted with all the **supplementary air heater** heating elements activated as allowed by the unit controls with the thermostats over-ridden. If the unit controls do not allow all **supplementary air heater** heating elements to be activated by over-riding the thermostats, then the test shall be conducted with the thermostats over-ridden and the air temperature reduced to a value which causes all the elements to switch on.

For appliances with **supplementary air heaters**, the heat provided by the **heat pump** may be simulated by use of an alternate heating source equal to the capacity of the **heat pump** when operated under the conditions of Clause 11. If at any condition during the tests of 19.104 the **heat pump** operation is interrupted by a protective control, the alternate heat source shall be interrupted in the same way.

19.104.2 Restricted inlet – 1st limit cut-out

To test limit cut-out conditions, the airflow conditions specified are established, the indoor airflow is reduced by restricting the inlet air opening to a rate resulting in not more than 1 K/min outlet air temperature rise until a **self-resetting thermal cut-out** device operates for the first time as a result of slowly restricting the free area of the inlet.

The outlet air temperature, measured by means of the thermocouple grid, shall not exceed 90 °C.

19.104.3 Restricted inlet – minimum airflow

To test heating operation conditions, after the airflow conditions specified are established, the indoor airflow is reduced by restricting the inlet air opening to such an extent that the temperature of the air in the outlet is 3 K below the temperature obtained after a **self-resetting thermal cut-out** device operates for the first time as a result of slowly restricting the free area of the inlet.

The appliance shall be operated until steady state conditions are established or for 1 h, whichever is longer. During the test, the temperatures are monitored continuously and shall not exceed the values shown in Table 3.

To facilitate this test, the **self-resetting thermal cut-out** which has operated in 19.104.2 may be short-circuited, if necessary.

NOTE Tests of 19.104.4 can be conducted immediately after the tests of 19.104.2.

19.104.4 Restricted inlet – restrict inlet to fully blocked

To test restricted inlet conditions, after the airflow conditions specified are established, the indoor airflow is reduced by restricting the inlet air opening at a rate resulting in not more than 1 K/min outlet air temperature rise until a **self-resetting thermal cut-out** device operates.

The restriction shall be halted after any **protective device** operates until steady state conditions are established. After steady state conditions are reached, the restriction is resumed. The test shall continue until the inlet is fully restricted.

The temperatures are monitored continuously. Temperatures shall not exceed the values shown in Table 3 + 30 K during the first hour and Table 3 thereafter.

19.104.5 Fan failure

To test fan failure conditions, after steady state conditions are attained, heat transfer medium flow of the indoor **heat exchanger** is restricted or shut off, whichever is the most unfavourable without the appliance being non-operative.

Temperatures shall not exceed the values shown in 19.13.

19.104.6 Blocked outlet

To test blocked outlet conditions, when steady conditions are attained, the appliance outlet air opening is totally closed off and operation continued until maximum temperatures are determined.

This test with the outlet air opening closed shall not be conducted on any unit with free air discharge openings located more than 1,2 m above the floor level when the unit is installed as intended.

Temperatures shall not exceed the values in 19.13.

19.104.7 Curtain drape

All appliances provided with **supplementary air heaters** and with free air discharge openings are subjected to the following test in each mode of operation.

This test shall not be conducted on any unit with free air discharge openings located more than 1,8 m above the floor level when the unit is installed as intended.

Appliances are operated under the conditions specified in Clause 11, with any controls which limit the temperature during the test of Clause 11 short-circuited, and with the appliance covered.

The covering is made with felt strips each having a width of 100 mm and lined with a single layer of textile material.

The felt has a specified mass of $4 \text{ kg/m}^2 \pm 0,4 \text{ kg/m}^2$ and a thickness of 25 mm.

The textile material consists of a prewashed double-hemmed cotton sheet having a mass between 140 g/m^2 and 175 g/m^2 in the dry condition.

Thermocouples are attached to the back of small blackened disks of copper or brass, 15 mm in diameter and 1 mm thick.

The disks are spaced 50 mm apart and placed between the textile material and the felt on the vertical centre line of each strip.

The disks are supported in such a way as to prevent them from sinking into the felt.

The strips are applied with the textile material in contact with the appliance so that they cover the whole vertical dimension of the front, pass over the top and extend down the rear surface.

If the appliance is constructed to stand away from the wall or if it is for fixing to a wall so that the gap between the heater and the wall exceeds 30 mm and the horizontal components of the distance between any two fixing points or spacers or between such points and the end of the appliance exceed 100 mm, the rear surface of the appliance shall be completely covered.

Otherwise, the rear surface is covered over a distance approximately equal to one-fifth of the vertical dimension of the heater.

The strips are applied to each half of the appliance in turn and then to the complete appliance.

During the test, the temperature shall not exceed 150°C except that an overshoot of 25 K is permitted during the first hour.

*Thermal **protective devices** are allowed to operate.*

19.104.8 Back up protection test

*If a **self-resetting thermal cut-out** operates during the tests of 19.104, then the **self-resetting thermal cut-out** shall be by-passed and the tests of 19.104.4 through 19.104.7 shall be repeated.*

For the test of 19.104.4, the rate of restriction shall be such that the opening is totally blocked at the end of 30 min.

Temperatures shall not exceed the values in 19.13.

19.105 For **dehumidifiers** in which the compressor is enclosed by a non-metallic material which isolates it from the forced air stream providing air to the **heat exchanger**, the following test shall apply.

The test shall be conducted under each of the following conditions:

- with 75 % of the charge removed;
- with the system pressure less than 0,12 MPa, but not less than 0,10 MPa with the appliance de-energized.

*The appliance shall be operated under the conditions of Clause 11 at the lower limit of the **rated voltage range** and an ambient temperature of $23\text{ °C} \pm 5\text{ °C}$. The appliance shall be operated until all components and the enclosure temperatures stabilize or are declining, but for not less than 24 h, or until the operation of the compressor is terminated by a non-self-resetting **protective device**. Any self-resetting **protective device** that actuates during this test shall be allowed to cycle as intended.*

Temperatures of non-metallic parts shall not exceed the relative thermal index of the material in accordance with IEC 60695-1-10.

Compliance is checked by test.

19.106 Double wall heat exchangers for **refrigerating systems** employing **flammable refrigerants** with **refrigerant charge** $m_c > m_1$ shall be resistant against freezing.

This requirement is not applicable to **double wall heat exchangers** which will only be exposed to temperatures above the freezing point of the secondary fluid.

NOTE 1 **Double wall heat exchangers** placed indoors in air-to-water **heat pumps** can be exposed to temperatures below 0 °C when defrosting using reverse cycle.

*Compliance is checked by confirming that not more than one of the **heat exchanger** walls is damaged or broken so that refrigerant leaks to the secondary circuit under the specified freezing conditions. Leaks between refrigerant and atmosphere are not critical.*

NOTE 2 Usually the separating walls of **double wall heat exchangers** are brazed together in some areas. At those brazing points freezing water can destroy both separating walls at once.

If the two walls separating secondary circuit and refrigeration circuit are brazed or welded together in some areas where water can be entrapped and break the heat exchanger by expansion due to freezing, then the test in Clause GG.6 item 2 a), b) and d) is performed in a refrigeration circuit with one of the safety measures to avoid freezing disabled. Each freezing cycle shall run for 5 min whether the compressor is switched off by a safety measure or not.

NOTE 3 A resistor can offset a temperature sensor to simulate a faulty sensor

The freezing test is repeated until a wall leaks, the control system detects an error, or 100 freezing cycles are completed, whichever occurs first.

During the test the refrigerant shall not leak into the secondary circuit.

NOTE 4 The failure of the **heat exchanger** can be recognized by monitoring the pressure of the secondary circuit if the secondary circuit is a closed loop and the saturated pressure of the refrigerant at the freezing point of the secondary fluid is above the pressure in the secondary circuit.

20 Stability and mechanical hazards

20.1 Appliances, other than **fixed appliances** and **hand-held appliances**, intended to be used on a surface such as the floor or a table, shall have adequate stability.

Compliance is checked by the following test, appliances incorporating an appliance inlet being fitted with an appropriate connector and flexible cord.

*The appliance, not connected to the supply mains, is placed in any normal position of use on a plane inclined at an angle of 10° to the horizontal, the **supply cord** resting on the inclined plane in the most unfavourable position. However, if part of an appliance comes into contact with the horizontal supporting surface when the appliance is tilted through an angle of 10°, the appliance is placed on a horizontal support and tilted in the most unfavourable direction through an angle of 10°.*

The test on the horizontal support may be necessary for appliances provided with rollers, castors or feet. In this case, castors or wheels may be blocked to prevent the appliance from rolling.

Appliances provided with doors are tested with the doors open or closed, whichever is the more unfavourable.

Appliances intended to be filled with liquid by the user in normal use are tested empty or filled with the most unfavourable quantity of water up to the capacity indicated in the instructions.

The appliance shall not overturn.

The test is repeated on appliances with heating elements with the angle of inclination increased to 15°. If the appliance overturns in one or more positions, it is subjected to the tests of Clause 11 in each of these overturned positions.

During this test, temperature rises shall not exceed the values shown in Table 9.

Fixed appliances that are only fixed into position by water piping, refrigerant piping or other piping are also subjected to this test.

Such pipes are not connected to the appliance during this test.

20.2 Moving parts of appliances shall, as far as is compatible with the use and working of the appliance, be positioned or enclosed to provide adequate protection against personal injury in normal use. This requirement does not apply to parts of an appliance that necessarily have to be exposed to allow the appliance to perform its working function.

NOTE 1 Examples of parts of appliances necessarily exposed to perform the working function include the needle of a sewing machine, rotating brushes of vacuum cleaner and the blade of an electrical knife.

Protective enclosures, guards and similar parts shall be **non-detachable parts** and shall have adequate mechanical strength. However, enclosures that can be opened by overriding an interlock by applying the test probe are considered to be **detachable parts**.

The unexpected closure of **self-resetting thermal cut-outs** and overcurrent **protective devices** shall not cause a hazard.

NOTE 2 An example of an appliance in which **self-resetting thermal cut-outs** and overcurrent **protective devices** could cause a hazard is an appliance having parts that are necessarily exposed so that it can perform its working function.

Test probe 18 of IEC 61032 is not applied to parts of appliances that, according to the installation instructions, are required to be mounted at a height exceeding 1,8 m above the floor.

Compliance is checked by:

- inspection;
- the test of 21.1;
- applying a force not exceeding 5 N by means of a test probe that is similar to test probe B of IEC 61032 but having a circular stop face with a diameter of 50 mm, instead of the non-circular face; and
- applying test probe 18 of IEC 61032 with a force not exceeding 2,5 N.

Test probe 18 is not applied to appliances for commercial use unless they are intended to be installed in an area open to the public.

For appliances provided with movable devices such as those intended for varying the tension of belts, the test with the test probe is carried out with these devices adjusted to the most unfavourable position within their range of adjustment. If necessary, belts are removed.

It shall not be possible to touch dangerous moving parts with the test probes.

21 Mechanical strength

21.1 Appliances shall have adequate mechanical strength and be constructed to withstand such rough handling that may be expected in normal use.

Pressure vessels shall comply with the requirements of ISO 5149-2:2014, 4.4.2.

The pressure test in Annex EE applies to parts other than **pressure vessels**.

Compliance is checked by applying blows to the appliance in accordance with test Ehb of IEC 60068-2-75, the spring hammer test.

The appliance is rigidly supported and three blows, having an impact energy of 0,5 J, are applied to every point of the enclosure that is likely to be weak.

If necessary, the blows are also applied to handles, levers, knobs and similar parts and to signal lamps and their covers but only if the lamps or covers protrude from the enclosure by more than 10 mm or if their surface area exceeds 4 cm². Lamps within the appliance and their covers are only tested if they are likely to be damaged in normal use.

When applying the release cone to the guard of a **visibly glowing heating element**, the hammer head passing through the guard shall not strike the heating element.

For appliances and parts of appliances having pins for insertion into mains socket-outlets, compliance is checked by subjecting the part of the appliance incorporating the pins to the test, Free fall repeated, procedure 2, of IEC 60068-2-31.

The number of falls is:

- 100, if the mass of the part does not exceed 250 g;
- 50, if the mass of the part exceeds 250 g.

The height of the falls is 500 mm.

After the tests, the appliance shall show no damage that could impair compliance with this standard and compliance with 8.1, 15.1 and Clause 29 shall not be impaired. In case of doubt, **supplementary insulation** and **reinforced insulation** are subjected to the electric strength test of 16.3.

Damage to the finish, small dents that do not reduce **clearances** or **creepage distances** below the values specified in Clause 29, and small chips that do not adversely affect protection against access to **live parts** or moisture, are ignored.

If a decorative cover is protected by an inner cover, fracture of the decorative cover is ignored if the inner cover itself withstands the test.

If there is doubt as to whether a defect has occurred by the application of the preceding blows or the previous tests, this defect is neglected and the group of three blows is applied to the same place on a new sample which shall then withstand the test.

Cracks not visible to the naked eye and surface cracks in fibre-reinforced mouldings and similar materials are ignored.

21.2 Accessible parts of solid insulation shall have sufficient strength to prevent penetration by sharp implements.

Compliance is checked by subjecting the insulation to the following test, unless the thickness of **supplementary insulation** is at least 1 mm and that of **reinforced insulation** is at least 2 mm. For **accessible parts** made of **particle foam material** used as **supplementary insulation** or **reinforced insulation**, the following test is done without any consideration of the insulation thickness.

The insulation is raised to the temperature measured during the test of Clause 11. The surface of the insulation is then scratched by means of a hardened steel pin, the end of which has the form of a cone with an angle of 40°. Its tip is rounded with a radius of 0,25 mm ± 0,02 mm. The pin is held at any angle from 80° to 85° to the horizontal and loaded so that the force exerted along its axis is 10 N ± 0,5 N. The scratches are made by drawing the pin along the surface of the insulation at a speed of approximately 20 mm/s. Two parallel scratches are made. They are spaced sufficiently apart so that they are not affected by each other, their length covering approximately 25 % of the length of the insulation. Two similar scratches are made at 90° to the first pair without crossing them.

The test fingernail of Figure 7 is then applied to the scratched surface with a force of approximately 10 N. No further damage, such as separation of the material, shall occur. The insulation shall then withstand the electric strength test of 16.3.

The hardened steel pin is then applied perpendicularly with a force of 30 N ± 0,5 N to an unscratched part of the surface. The insulation shall then withstand the electric strength test of 16.3 with the pin still applied and used as one of the electrodes.

21.3 Appliances with pins for insertion into socket-outlets where the plug part is capable of rotation shall be provided with a mechanical stop to prevent rotation beyond which stress to electrical connections and internal wiring may occur. The mechanical stop shall have adequate mechanical strength and be constructed to withstand such rough handling that may be expected in normal use.

Compliance is checked by inspection and by the following test.

The part relying upon the mechanical stop shall be rotated as intended until the mechanical stop prevents further rotation. A torque of 2 Nm is then applied for 1 min in an attempt to override the mechanical stop. The part relying upon the mechanical stop shall not rotate.

The test shall be repeated in the opposite direction of rotation.

21.101 Appliances using **flammable refrigerants** shall withstand the effects of vibration during transport.

The appliance is tested in its final packaging for transport, fixed to the vibration table, and shall withstand a random vibration test for 180 min according to ISO 13355 with the power spectral density profile specified in Table 101.

Table 101 – Power spectral density profile for vibration test

Frequency Hz	Level (m/s ²) ² /Hz
1	0,004 8
4	0,961 7
16	0,961 7
40	0,096 2
80	0,096 2
200	0,001 0
In between values are to be interpolated as shown in Figure 104.	
NOTE The RMS value is 5,1 m/s ² .	

Where testing to ISO 13355 is impractical due to limitations of available test facilities/equipment within the industry, the appliance shall be tested by a transport test representative of shipping mode such as truck, rail, air, and/or ocean. Truck transport test is mandatory. Rail, air, and/or ocean transport tests are optional.

The product shall be transported for a distance of not less than 2 times the longest expected transportation route as determined by the manufacturer in consideration of the product marketplace and distribution. For truck transport, at least 3 categories of roads shall be used, representing the expected transportation route with at least 10 % of the total distance for each road category.

Compliance is checked by the following:

- *the use of detection equipment having an equivalent sensitivity of 3 g/year of refrigerant shall reveal no leaks;*
- *damage of parts other than the refrigerating circuit is allowed.*

NOTE The test can be carried out on the appliance charged with a non-flammable refrigerant or a non-hazardous gas when pressurized to the saturated vapour pressure corresponding to a temperature of 23 °C.

21.102 Double wall heat exchangers for refrigerating systems employing **flammable refrigerant** with **refrigerant charge** $m_c > m_1$ shall be constructed in a way that they do not allow refrigerants to leak into the secondary circuit if one of the walls breaks.

Each of the two walls separating secondary circuit and refrigeration circuit shall withstand the pressure test of Annex EE. In case of vented intermediate chamber, only the wall on the refrigerant side shall withstand the pressure test of Annex EE.

Compliance is checked by the pressure test of Annex EE, which is carried out

- *on a closed intermediate chamber: with one wall broken in turn;*
- *on a vented intermediate chamber: only on the refrigerant side.*

22 Construction

22.1 If the appliance is marked with the first numeral of the IP system or any of the additional letters of the IP system, the relevant requirements of IEC 60529:1989 including IEC 60529:1989/AMD1:1999 and IEC 60529:1989/AMD2:2013 shall be fulfilled.

Compliance is checked by the relevant tests.

22.2 For **stationary appliances**, means shall be provided to ensure disconnection from the supply mains. Such means shall be one of the following:

- a **supply cord** fitted with a plug;
- a switch providing **all-pole disconnection** and complying with 24.3;
- a statement in the instructions that a disconnection incorporated in the fixed wiring is to be provided;
- an appliance inlet.

Single-pole switches and single-pole **protective devices** that disconnect heating elements from the supply mains in single-phase, permanently connected **class 01 appliances** and **class I appliances** shall be connected to the line conductor.

Compliance is checked by inspection.

22.3 Appliances with pins for insertion into socket-outlets shall not impose undue strain on these socket-outlets. The means for retaining the pins shall withstand the forces to which the pins are likely to be subjected in normal use.

Compliance is checked by inserting the pins of the appliance into a socket-outlet. The socket-outlet has a horizontal pivot at a distance of 8 mm behind the engagement face of the socket-outlet and in the plane of the contact apertures.

The torque that has to be applied to maintain the engagement face of the socket-outlet in the vertical plane shall not exceed 0,25 Nm. The torque to keep the socket-outlet itself in the vertical plane is not included in this value.

A new sample of the appliance is firmly held so that the retention of the pins is not affected. The appliance is placed in a heating cabinet for 1 h at a temperature of $70\text{ °C} \pm 2\text{ °C}$. The appliance is then removed from the heating cabinet and a pull force of 50 N is immediately applied for 1 min to each pin along their longitudinal axes.

*When the appliance has cooled down to **room temperature**, the pins shall not have been displaced by more than 1 mm.*

Each pin is then subjected in turn to a torque of 0,4 Nm, which is applied for 1 min in each direction. The pins shall not rotate unless rotation does not impair compliance with this standard.

22.4 Appliances for heating liquids and appliances causing undue vibration shall not be provided with pins for insertion into socket-outlets.

Compliance is checked by inspection.

22.5 Appliances intended to be connected to the supply mains by means of a plug or pins for insertion into socket-outlets shall be constructed so that in normal use, when pins are touched,

there is no risk of electric shock from charged capacitors that result in a capacitance equal to or greater than 0,1 μF across any two pins.

Compliance is checked by the following test.

*The appliance is supplied at **rated voltage**. Any switch is then placed in the **off position** and the appliance is disconnected from the supply mains at the instant of voltage peak. One second after disconnection, the voltage between the pins of the plug is measured with an instrument having an input impedance of not less than 100 M Ω in parallel with an input capacitance not exceeding 25 pF.*

The voltage shall not exceed 34 V.

*If compliance relies on the operation of an **electronic circuit**, the electromagnetic phenomena tests of 19.11.4.3 and 19.11.4.4 are applied one at a time to the appliance. The test for measuring the voltage between the pins of the plug is then repeated three times and for each test, the voltage shall not exceed 34 V.*

22.6 Appliances shall be constructed so that their electrical insulation cannot be affected by water that could condense on cold surfaces or by liquid that could leak from containers, hoses, couplings and similar parts of the appliance. The electrical insulation of **class II appliances** and **class II constructions** shall not be affected if a hose ruptures or a seal leaks.

The electrical insulation shall not be affected by snow which might enter the appliance enclosure.

Compliance is checked by inspection and, in case of doubt, by the following test.

Drops of coloured water solution are applied by a syringe to parts inside the appliance where leakage of a liquid could occur and affect electrical insulation. The appliance is in operation or at rest, whichever is the more unfavourable.

*After this test, inspection shall show that there is no trace of liquid on windings or insulation that could result in a reduction of **creepage distances** below the values specified in 29.2.*

22.7 Appliances containing liquid or gases in normal use or having steam-producing devices shall incorporate adequate safeguards against the risk of excessive pressure.

Compliance is checked by inspection and, if necessary, by an appropriate test.

22.8 For appliances having compartments to which access can be gained without the aid of a **tool** and that are likely to be cleaned in normal use, the electrical connections shall be arranged so that they are not subject to pulling during cleaning.

Compliance is checked by inspection and by manual test.

22.9 Appliances shall be constructed so that parts such as insulation, internal wiring, windings, commutators and slip rings are not exposed to oil, grease or similar substances, unless the substance has adequate insulating properties so that compliance with this standard is not impaired.

Compliance is checked by inspection and by the tests of this standard.

22.10 It shall not be possible to reset voltage-maintained **non-self-resetting thermal cut-outs** by the operation of an automatic switching device incorporated within the appliance. This

requirement is only applicable if a **non-self-resetting thermal cut-out** is required by this standard and a voltage maintained **non-self-resetting thermal cut-out** is used to meet it.

NOTE 1 Voltage-maintained controls are intended to automatically reset if they become de-energized.

Non-self-resetting thermal motor protectors shall have a trip-free action unless they are voltage maintained.

NOTE 2 Trip-free is an automatic action that is independent of manipulation or position of the actuating member.

Reset buttons of **non-self-resetting controls** shall be located or protected so that their accidental resetting is unlikely to occur if this could result in a hazard.

NOTE 3 For example, this requirement precludes the location of reset buttons on the back of an appliance, which could result in them being reset by pushing the appliance against a wall.

Compliance is checked by inspection.

22.11 Non-detachable parts that protect against access to **live parts**, moisture or contact with moving parts shall be fixed in a reliable manner and withstand the mechanical stress occurring during normal use. Snap-in devices used for fixing such parts shall have an obvious locked position. The fixing properties of snap-in devices used in parts that are likely to be removed during installation or servicing shall be reliable.

Compliance is checked by the following tests.

Parts that are likely to be removed during installation or servicing are disassembled and assembled 10 times before the test is carried out.

NOTE Servicing includes replacement of the **supply cord**, except in appliances with a **Type Z attachment**.

*The test is carried out at **room temperature**. However, if compliance may be affected by the temperature of the appliance, the test is also carried out immediately after it has been operated under the conditions specified in Clause 11.*

The test is applied to all parts that are likely to be detachable whether or not they are fixed by screws, rivets or similar parts.

A force is applied without jerks for 10 s in the most unfavourable direction to parts likely to be weak. The force is as follows:

- *push force, 50 N;*
- *pull force:*
 - *if the shape of the part is such that the fingertips cannot easily slip off, 50 N;*
 - *if the projection of the part that is gripped is less than 10 mm in the direction of removal, 30 N.*

The push force is applied by test probe 11 of IEC 61032.

The pull force is applied by a suitable means, such as a suction cup, so that the test results are not affected. While the force is being applied, the test fingernail of Figure 7 is inserted in any aperture or joint with a force of 10 N. The fingernail is then slid sideways with a force of 10 N but is not twisted or used as a lever.

If the shape of the part is such that an axial pull is unlikely, the pull force is not applied but the test fingernail is inserted in any aperture or joint with a force of 10 N and is then pulled for 10 s by means of the loop with a force of 30 N in the direction of removal.

If the part is likely to be twisted, the following torque is applied at the same time as the pull or push force:

- 2 Nm, for major dimensions up to 50 mm;
- 4 Nm, for major dimensions over 50 mm.

This torque is also applied when the test fingernail is pulled by means of the loop.

If the projection of the part which is gripped is less than 10 mm, the torque is reduced by 50 %.

Parts shall remain in the locked position and not become detached.

22.12 Handles, knobs, grips, levers and parts providing a similar function shall be fixed in a reliable manner so that they will not work loose in normal use if loosening could result in a hazard, including a choking hazard. If these parts are used to indicate the position of switches or similar components, it shall not be possible to remove or fix them incorrectly if this could result in a hazard. The requirement concerning the choking hazard does not apply to appliances intended for commercial use.

Sealing compound and similar materials, other than self-hardening resins, shall not be used to prevent loosening.

Compliance is checked by inspection, by manual test and by trying to remove the part by applying an axial force of:

- 15 N, if an axial pull is unlikely to be applied in normal use;
- 30 N, if an axial pull is likely to be applied in normal use.

The force is applied for 1 min.

If the part is removed and can be contained within the small parts cylinder in Figure 13, its loosening is considered to result in a choking hazard.

22.13 Appliances shall be constructed so that when handles are gripped in normal use, contact is unlikely between the operator's hand and parts having a temperature rise exceeding the value specified in Table 3 for handles which are held for short periods only in normal use.

Compliance is checked by inspection and, if necessary, by determining the temperature rise.

22.14 Appliances shall have no ragged or sharp edges, other than those necessary for the functioning of the appliance, which could create a hazard for the user in normal use or during **user maintenance**.

Pointed ends of self-tapping screws or other fasteners shall be located so that they are unlikely to be touched by the user in normal use or during **user maintenance**.

This requirement does not apply to the metallic fins of **heat exchangers**.

Compliance is checked by inspection.

22.15 Storage hooks and similar devices for flexible cords shall be smooth and well-rounded.

Compliance is checked by inspection.

22.16 Automatic cord reels shall be constructed so that they do not cause:

- undue abrasion or damage to the sheath of the flexible cord;

- breakage of conductor strands;
- undue wear of contacts.

Compliance is checked by the following test, which is carried out without passing current through the flexible cord.

Two-thirds of the length of the cord is unreeled. If the withdrawable length of the cord is less than 225 cm, the cord is unreeled so that a length of 75 cm remains on the reel. An additional length of 75 cm of the cord is then unreeled and pulled in a direction so that the greatest abrasion occurs to the sheath, taking into account the normal position of use of the appliance. Where the cord leaves the appliance, the angle between the axis of the cord during the test and the axis of the cord when it is unreeled without substantial resistance is approximately 60°. The cord is allowed to be recoiled by the reel.

If the cord does not recoil at the angle of 60°, this angle is adjusted to the maximum that will allow recoil.

The test is carried out 6 000 times at a rate of approximately 30 times per minute or at the maximum rate allowed by the construction of the cord reel if this is less.

NOTE The test can be interrupted to allow the cord to cool.

After this test, the cord and cord reel are inspected. In case of doubt the cord is subjected to the electric strength test of 16.3, a test voltage of 1 000 V being applied between the conductors of the cord connected together and metal foil wrapped around the cord.

22.17 Spacers intended to prevent the appliance from overheating walls shall be fixed so that it is not possible to remove them from the outside of the appliance by hand or by means of a screwdriver or a spanner.

Compliance is checked by inspection and by manual test.

22.18 Current-carrying parts and other metal parts, the corrosion of which could result in a hazard, shall be resistant to corrosion under normal conditions of use.

The requirement is not applicable to parts made from stainless steel, plated steel and similar corrosion-resistant alloys.

Compliance is checked by verifying that after the tests of Clause 19, the relevant parts show no sign of corrosion.

NOTE Compatibility of the materials of terminals and the effect of heating can influence corrosion.

22.19 Driving belts shall not be relied upon to provide the required level of insulation unless they are constructed to prevent inappropriate replacement.

Compliance is checked by inspection.

22.20 Direct contact between **live parts** and thermal insulation shall be effectively prevented unless such material is non-corrosive, non-hygrosopic and non-combustible.

The requirement is not applicable to glass-wool thermal insulation.

NOTE Non-impregnated slag-wool is an example of corrosive thermal insulation.

Compliance is checked by inspection and, if necessary, by appropriate tests.

22.21 Wood, cotton, silk, ordinary paper and similar fibrous or hygroscopic material shall not be used as insulation, unless impregnated. This requirement does not apply:

- to magnesium oxide and mineral ceramic fibres used for the electrical insulation of heating elements;
- insulating material where the interstices between the fibres of the material are substantially filled with a suitable insulant.

Compliance is checked by inspection.

22.22 Appliances shall not contain asbestos.

Compliance is checked by inspection.

22.23 Oils containing polychlorinated biphenyl (PCB) shall not be used in appliances.

Compliance is checked by inspection.

22.24 Bare heating elements shall be supported so that, in case of rupture or sagging, the heating conductor cannot come into contact with accessible metal parts nor give rise to a hazard. Bare heating elements shall not be used with wood or wood composite enclosures.

Compliance is checked by inspection and, if necessary, by cutting the element in the most unfavourable place. No force shall be applied to the conductor after it has been cut.

This test shall be made after the tests of Clause 29.

22.25 Appliances shall be constructed so that sagging heating conductors cannot come into contact with **accessible metal parts**. This requirement does not apply:

- to **class III appliances** or parts of **class III constructions** that do not contain **live parts**;
- where a core is provided that effectively prevents the heating conductor from sagging; or
- where **supplementary insulation** is provided to prevent the heating conductor from contacting **accessible metal parts**.

Compliance is checked by inspection.

22.26 Appliances having parts of **class III construction** shall be constructed so that the insulation between parts operating at **safety extra-low voltage** and other **live parts** complies with the requirements for **double insulation** or **reinforced insulation**.

*Compliance is checked by the tests specified for **double insulation** or **reinforced insulation**.*

22.27 Parts connected by **protective impedance** shall be separated by **double insulation** or **reinforced insulation**.

*Compliance is checked by the tests specified for **double insulation** or **reinforced insulation**.*

22.28 For **class II appliances** connected in normal use to the gas mains or to the water mains, metal parts conductively connected to the gas pipes or in contact with the water shall be separated from **live parts** by **double insulation** or **reinforced insulation**.

Compliance is checked by inspection.

22.29 Class II appliances intended to be permanently connected to fixed wiring shall be constructed so that the required degree of access to **live parts** is maintained after installation.

NOTE The protection against access to **live parts** can be affected, for example, by the installation of metal conduits or cables provided with a metal sheath.

Compliance is checked by inspection.

22.30 Parts of **class II construction** which serve as **supplementary insulation** or **reinforced insulation**, and which could be omitted during reassembly after servicing, shall be:

- fixed so that they cannot be removed without being seriously damaged; or
- constructed so that they cannot be replaced in an incorrect position and if they are omitted, the appliance is rendered inoperable or manifestly incomplete.

NOTE Servicing includes replacement of components such as **supply cords** except in appliances having a **Type Z attachment** and switches.

Compliance is checked by inspection and by manual test.

22.31 Neither **clearances** nor **creepage distances** over **supplementary insulation** and **reinforced insulation** shall be reduced below the values specified in Clause 29 as a result of wear.

If a part, such as a wire, screw, nut or spring, becomes loose or falls out of position, neither **clearances** nor **creepage distances** between **live parts** and **accessible parts** shall be reduced below the values specified for **supplementary insulation**. This requirement does not apply if:

- parts are fixed by means of screws or nuts and locking washers provided that these screws or nuts are not required to be removed during the replacement of the **supply cord** or other servicing;
- short rigid wires remain in position when the terminal screw is loosened;
- parts are held in place with two independent fixings that are not expected to become loose at the same time;
- wires connected by soldering are held in place near the terminals independently of the solder;
- wires connected to terminals have an additional fixing provided near the terminal, so that in the case of stranded conductors, the fixing clamps both the insulation and conductor.

With the appliance in its normal position of use, compliance is checked by inspection, by manual test and by measurement.

22.32 **Supplementary insulation** and **reinforced insulation** shall be constructed or protected so that the deposition of pollution resulting from wear of parts within the appliance does not reduce **clearances** or **creepage distances** below the values specified in Clause 29.

Parts of natural or synthetic rubber used as **supplementary insulation** shall be resistant to ageing or be located and dimensioned so that **creepage distances** are not reduced below the values specified in 29.2, even if cracks occur.

Ceramic material which is not tightly sintered, similar materials or beads alone shall not be used as **supplementary insulation** or **reinforced insulation**. Ceramic and similar porous material in which heating conductors are embedded is considered to be **basic insulation** and not **reinforced insulation**. This requirement is not applicable to heating conductors in **PTC heating elements**.

Compliance is checked by inspection and by measurement.

If the rubber part has to be resistant to ageing, the following test is carried out.

The part is suspended freely in an oxygen bomb, the effective capacity of the bomb being at least 10 times the volume of the part. The bomb is filled with oxygen not less than 97 % pure, to a pressure of $2,1 \text{ MPa} \pm 0,07 \text{ MPa}$ and maintained at a temperature of $70 \text{ }^{\circ}\text{C} \pm 1 \text{ }^{\circ}\text{C}$.

WARNING – *The use of the oxygen bomb presents some danger unless handled with care. Precautions shall be taken to avoid the risk of explosion due to sudden oxidation.*

*The part is kept in the bomb for 96 h. It is then removed from the bomb and left at **room temperature** out of direct sunlight for at least 16 h.*

The part is then examined and shall show no crack visible to the naked eye.

In case of doubt, the following test is carried out to determine if ceramic material is tightly sintered.

The ceramic material is broken into pieces that are immersed in a solution containing 1 g of fuchsine in each 100 g of methylated spirit. The solution is maintained at a pressure not less than 15 MPa for a period so that the product of the test duration in hours and the test pressure in megapascals is approximately 180.

The pieces are removed from the solution, rinsed, dried and broken into smaller pieces.

The freshly broken surfaces are examined and shall not show any trace of dye visible to the naked eye.

22.33 Conductive liquids that are or may become accessible in normal use and conductive liquids that are in contact with unearthed **accessible metal parts** shall not be in direct contact with **live parts** or unearthed metal parts that are separated from **live parts** by **basic insulation** only.

Electrodes shall not be used for heating liquids.

For **class II construction**, conductive liquids that are or may become accessible in normal use and conductive liquids that are in contact with unearthed **accessible metal parts** shall not be in direct contact with **basic insulation** or **reinforced insulation** unless the **reinforced insulation** consists of at least 3 layers.

For **class II construction**, conductive liquids which are in contact with **live parts** shall not be in direct contact with **reinforced insulation** unless the **reinforced insulation** consists of at least 3 layers.

An air layer shall not be used as **basic insulation** or **supplementary insulation** in a **double insulation** system if it is likely to be bridged by leaking liquid.

Compliance is checked by inspection.

22.34 Shafts of operating knobs, handles, levers and similar parts shall not be live unless the shaft is inaccessible when the part is removed.

*Compliance is checked by inspection and by applying the test probe as specified in 8.1 after removal of the part even with the aid of a **tool**.*

22.35 For other than **class III constructions**, handles, levers and knobs that are held or actuated in normal use shall not become live in the event of a failure of **basic insulation**.

If these handles, levers and knobs are of metal and if their shafts or fixings are likely to become live in the event of a failure of **basic insulation**, they shall be adequately covered by insulating material or their **accessible parts** shall be separated from their shafts or fixings by **supplementary insulation**.

For **stationary appliances** and cordless appliances, this requirement does not apply to handles, levers and knobs, other than those of electrical components, provided that they are reliably connected to an earthing terminal or earthing contact or separated from **live parts** by earthed metal.

NOTE A cordless appliance is an appliance that is connected to the supply only when placed on its associated stand.

Compliance is checked by inspection and if necessary by the relevant tests.

*Insulating material covering metal handles, levers and knobs shall withstand the electric strength test of 16.3 specified for **supplementary insulation**.*

22.36 For appliances other than **class III appliances**, handles which are continuously held in the hand in normal use shall be constructed so that when gripped in normal use, the operator's hand is not likely to touch metal parts unless they are separated from **live parts** by **double insulation** or **reinforced insulation**.

Compliance is checked by inspection.

22.37 For **class II appliances**, capacitors shall not be connected to **accessible metal parts** and their casings, if of metal, shall be separated from **accessible metal parts** by **supplementary insulation**.

This requirement does not apply to capacitors complying with the requirements for **protective impedance** specified in 22.42.

Compliance is checked by inspection and by the relevant tests.

22.38 Capacitors shall not be connected between the contacts of a **thermal cut-out**.

Compliance is checked by inspection.

22.39 Lampholders shall be used only for the connection of lamps.

Compliance is checked by inspection.

22.40 **Motor-operated appliances** and **combined appliances** which are intended to be moved while in operation, or which have **accessible moving parts**, shall be fitted with a switch to control the motor. The actuating member of this switch shall be easily visible and accessible.

The second paragraph is not applicable.

NOTE Examples of appliances that can operate continuously, automatically or remotely without giving rise to a hazard are fans, storage water heaters, air conditioners, refrigerators and drives for awnings, windows, doors, gates and shutters.

Compliance is checked by inspection.

22.41 Appliances shall not incorporate components, other than lamps, containing mercury.

Compliance is checked by inspection.

22.42 Protective impedance shall consist of at least two separate components. If any one of the components is short-circuited or open-circuited, the values specified in 8.1.4 shall not be exceeded.

Component impedances shall be unlikely to change significantly during the lifetime of the appliance.

Compliance is checked by inspection and by measurement and if necessary, for resistors and capacitors by the following tests.

*Resistors are checked by the test of 14.2 a) in IEC 60065:2014 and capacitors are checked by the tests for class Y capacitors in IEC 60384-14:2013 including IEC 60384-14:2013/AMD1:2016 appropriate to the **rated voltage** of the appliance.*

22.43 Appliances which can be adjusted for different voltages shall be constructed so that accidental changing of the setting is unlikely to occur.

Compliance is checked by manual test.

22.44 Appliances shall not have an enclosure that is shaped or decorated like a toy.

NOTE 1 Examples of such enclosures are those representing animals, characters, persons or scale models.

The requirement is not applicable to appliances where there is a toy shaped like the appliance.

NOTE 2 An example of a toy shaped like an appliance is a toy refrigerator.

Compliance is checked by inspection.

22.45 When air is used as **reinforced insulation**, the appliance shall be constructed so that **clearances** cannot be reduced below the values specified in 29.1.3 due to deformation as a result of an external force applied to the enclosure.

*Compliance is checked by inspection and by applying a force of 30 N to **accessible surfaces**.*

22.46 If programmable **protective electronic circuits** are used to ensure compliance with this standard, the software shall contain measures to control the fault/error conditions specified in Table R.1.

These requirements are not applicable to software used for functional purpose or for compliance with Clause 11.

Compliance is checked by evaluating the software in accordance with the relevant requirements of normative Annex R.

*If the software is modified, the evaluation and relevant tests are repeated if the modification influences the results of the test involving **protective electronic circuits**.*

22.47 Appliances intended to be connected to the water mains shall withstand the water pressure expected in normal use.

Compliance is checked by connecting the appliance to a water supply having a static pressure equal to twice the maximum inlet water pressure or 1,2 MPa, whichever is higher, for a period of 5 min.

There shall be no leakage from any part, including any inlet water hose.

22.48 Appliances intended to be connected to the water mains shall be constructed to prevent back-siphonage of non-potable water into the water mains.

Compliance is checked by the relevant tests of IEC 61770.

22.49 Not applicable.

22.50 Controls incorporated in the appliance, if any, shall take priority over controls actuated by **remote operation**.

Compliance is checked by inspection and by appropriate tests if necessary.

22.51 Not applicable.

22.52 Socket-outlets on appliances accessible to the user shall be in accordance with the socket-outlet system used in the country in which the appliance is sold.

Compliance is checked by inspection.

22.53 Class II appliances and **class III appliances** that incorporate functionally earthed parts shall have at least **double insulation** or **reinforced insulation** between **live parts** and the functionally earthed parts.

Compliance is checked by inspection and test.

22.54 Button **cells** and **batteries** designated R1 shall not be accessible without the aid of a **tool** unless the cover of their compartment can only be opened after at least two independent movements have been applied simultaneously.

Compliance is checked by inspection and by manual test.

NOTE **Batteries** are specified in IEC 60086-2.

22.55 Devices that are operated by the user to stop the intended function of the appliance, if any, shall be distinguished from other manual devices by means of shape, or size, or surface texture, or position. This requirement concerning position does not preclude use of a push on push off switch.

An indication when the device has been operated shall be given by:

- tactile feedback from the actuator or tactile feedback from the appliance such as stopping of the vibration on the body of the appliance or of a part of it; or
- reduction in heat output; or
- audible and visible feedback.

The sound of the motor or sound of an actuator switching from on to off is considered as an audible feedback. A switch with a stable **off-position** different from the on-position is considered visual and tactile feedback. The force feedback from the actuator when operating it is considered to be tactile feedback.

Compliance is checked by inspection and by manual test.

22.56 Detachable power supply part shall be provided with the part of **class III construction** of the appliance.

Compliance is checked by inspection.

22.57 The properties of non-metallic materials shall not degrade from exposure to UV-C radiation generated from UV sources provided for microbiological control within the appliance such that they no longer comply with this standard. This requirement does not apply to glass, ceramics or similar materials.

Compliance is checked by the conditioning and tests of normative Annex T.

22.58 Appliances connected to the supply mains by an appliance inlet, shall be provided with a cord set or a connector for attachment to a suitable flexible cord.

The requirement is not applicable to:

- appliances connected to the supply mains by an appliance inlet complying with the standard sheets of IEC 60320-3;
- single phase appliances having a **rated current** exceeding 16 A and that are connected to the supply mains by an appliance inlet complying with the standard sheets of IEC 60309-2;
- multi-phase appliances connected to the supply mains by an appliance inlet complying with the standard sheets of IEC 60309-2;

Compliance is checked by inspection.

22.59 Protective extra-low voltage circuits shall be separated by at least **supplementary insulation** from circuits operating at **safety extra-low voltage**.

NOTE **Supplementary insulation** is not required between **protective extra-low voltage circuits**.

*Compliance is checked by inspection and the tests for **supplementary insulation**.*

22.60 Functional earthing terminals and functional earthing contacts shall not be connected to the neutral terminal.

Compliance is checked by inspection.

22.61 Appliance outlets complying with the standard sheets in IEC 60320-3 accessible to the user and socket-outlets accessible to the user:

- that are incorporated in appliances connected to the supply mains; and
- that operate at **rated voltage**

shall be single phase with a current rating not exceeding 16 A.

Appliance outlets accessible to the user, other than those intended to supply accessories supplied with the appliance and socket-outlets accessible to the user shall be protected by one of the following **protective devices**, having a current rating not exceeding the current rating of the appliance outlet or socket-outlet:

- a circuit breaker for equipment complying with IEC 60934;
- a non-user replaceable fuse-link.

The **protective device** shall be placed behind a **non-detachable cover**. The actuating member of the circuit breaker may be accessible.

The current rating of appliance outlets and socket-outlets marked with the **outlet load** in watts, is obtained from the marked **outlet load** divided by the **rated voltage**.

Compliance is checked by inspection.

22.62 Remote communication through **public networks** shall not impair compliance with this standard.

The requirement is only applicable to:

- a) **remote communication** that includes the download of software or the transmission of data that includes:
- measures according to normative Annex R necessary for compliance with 22.46; or
 - means necessary for compliance with Clauses 8 to 32 of this standard.

NOTE 1 Examples of such means are constants, algorithms, timers or a downloaded software or parameter set which regulates or limits the maximum normal temperature rises in Clause 11.

NOTE 2 Examples of means which do not affect Clauses 8 to 32 of this standard are the change of speed setting of a range hood fan, operation of a drive to open or close a driven part or change of operational setting of an air conditioner, such as fan speed, heating and cooling temperatures and louver movement.

- b) **remote communication** that includes the download of software or the transmission of data, that only affects that part of the software that is not covered by the above case a), but where compliance with this standard may be impaired due to improper separation or partitioning from the software or data in the above case a).

The requirement is not applicable to appliances:

- where all measures to comply with this standard are independent of software;
- using **remote communication** through **public networks** for the send-only transmission of data; or
- that only provide event driven **messages** or push remote monitoring.

Compliance is checked by inspection of the product, inspection of the technical documentation, and by the requirements and tests in normative Annex U.

22.101 Appliances intended to be fixed shall be so designed that they can be securely fixed and maintained in position.

Compliance is checked by inspection and in case of doubt, after installation of the appliance, in accordance with the installation instructions.

22.102 For appliances provided with **supplementary heaters**:

22.102.1 Appliances provided with **supplementary air heaters** shall be provided with at least two **thermal cut-outs**. The **thermal cut-out** intended to operate first shall be either a **self-resetting thermal cut-out** or a **non-self-resetting thermal cut-out**; the other **thermal cut-out** shall be a **non-self-resetting thermal cut-out**.

Compliance is checked by inspection and during the tests of Clause 19.

22.102.2 Appliances provided with **supplementary water heaters** shall incorporate a **non-self-resetting thermal cut-out**, providing **all-pole disconnection** that operates separately from water **thermostats**. However, for appliances intended to be connected to fixed wiring, the neutral conductor need not be disconnected.

Compliance is checked by inspection and during the tests of Clause 19.

NOTE Anti-frost heaters are not considered to be **supplementary water heaters**, if it is not possible to heat up the water to a temperature higher than 80 °C at the highest operating temperature within 6 h, with the temperature switch short circuited and with water flow stopped.

22.102.3 **Thermal cut-outs** of the capillary type shall be so designed that the contacts open in the event of leakage from the capillary tube.

Compliance is checked by inspection and test.

22.103 The sensing and switching elements of electromechanical **non-self-resetting cut-outs** shall be functionally independent of other control devices. If the switching element of a **non-self-resetting cut-out** is operating a relay or contactor, the relay or contactor may also be operated by other control devices. **Protective electronic circuits** are covered by Clause 19.

Compliance is checked by inspection.

22.104 Containers of **sanitary hot water heat pumps** shall withstand the water pressure occurring in normal use.

*Compliance is checked by subjecting the containers and **heat exchangers**, if any, to a water pressure which is raised to the value specified below at a rate of 0,13 MPa per second and is maintained at that value for 5 min.*

The water pressure is

- twice the **maximum allowable pressure** for closed containers;
- 0,15 MPa for open containers.

After the test, no water shall have leaked out and the containers shall not have ruptured.

NOTE If the container of **sanitary hot water heat pumps** incorporates a **heat exchanger**, the container and the **heat exchanger** are subjected to the pressure test in accordance with the relevant standard.

22.105 In the case of closed containers of **sanitary hot water heat pumps**, the formation of an air or vapour cushion of more than 2 % of the capacity, but not more than 10 %, shall be provided.

Compliance is checked by inspection and, where necessary, by measurements.

22.106 Pressure-relief devices, whether incorporated in the container of **sanitary hot water heat pumps** or supplied separately, shall prevent the pressure in the container from exceeding the **maximum allowable pressure** by more than 0,1 MPa.

Compliance is checked by subjecting the container to a slowly increasing water pressure and by observing the pressure at which the relief device operates.

22.107 The outlet system of open containers of **sanitary hot water heat pumps** shall be free from obstructions that could limit the water flow to such an extent that the pressure in the container would exceed the **maximum allowable pressure**.

Vented containers of **sanitary hot water heat pumps** shall be so constructed that the container is always open to the atmosphere through an aperture of at least 5 mm in diameter or 20 mm² in area, with a width of at least 3 mm.

Compliance is checked by inspection and measurement.

NOTE The first requirement is considered to be met if the area of the water outlet from the heated part of the container of **sanitary hot water heat pumps** is equal or greater than the area of the water inlet to the heated part.

22.108 Storage tanks of **sanitary hot water heat pumps** shall be resistant to vacuum pressure impulses which can occur in normal use.

Compliance is checked by subjecting containers which are not vented, in accordance with 22.104, to a vacuum of 33 kPa for 15 min.

After the test, the container shall show no deformation which might result in a hazard.

Anti-vacuum valves, if any, are not rendered inoperative.

NOTE This test can be carried out on separate containers.

22.109 Wiring connected to a **non-self-resetting thermal cut-out** designed to be replaced after its operation shall be so secured that replacement of the **thermal cut-out** itself or to a heating element assembly on which the **thermal cut-out** is mounted will not damage other connections or internal wiring.

Compliance is checked by inspection and, if necessary, by manual test.

22.110 Non-self-resetting thermal cut-outs designed to be replaced after their operation shall open the circuit in the intended manner without short-circuiting **live parts** of different potential and without causing **live parts** to come into contact with the enclosure.

Compliance is checked by the following test.

*The appliance is operated five times, each time with a new **non-self-resetting thermal cut-out**, any other thermally operated control devices being short-circuited.*

*Each time, the **non-self-resetting thermal cut-out** shall operate appropriately.*

During the test, the enclosure of the appliance is connected to earth through a 3 A fuse; this fuse shall not blow.

After this test, the supplementary heating elements shall withstand an electric strength test as specified in 16.3.

22.111 Void.

22.112 The construction of the **refrigerating system** shall comply with the requirements of ISO 5149-2:2014, 4.2, 4.3, 5.2.1, 5.2.2, 5.2.4, 5.2.5, 5.2.15, 5.2.6.1, 5.2.6.3, 5.2.7, 5.2.8, 5.2.9.1, 5.2.9.3, and 5.2.9.4, ISO 5149-2:2014 and ISO 5149-2:2014/AMD1:2020, 5.2.3, and ISO 5149-2:2014/AMD1:2020, 4.1, 5.2.9.2.

NOTE A **safety shut-off valve** is an isolating valve for the purpose of ISO 5149-2.

Compliance is checked by inspection.

22.113 When a **flammable refrigerant** is used, refrigerant piping shall be protected or enclosed to avoid mechanical damage. The refrigerant piping shall be protected to the extent that it will not be handled or used for carrying during moving of the appliance. Refrigerant piping located within the appliance enclosure is considered to be protected from mechanical damage.

Compliance is checked by inspection.

22.114 When a **flammable refrigerant** is used, low temperature solder alloys, such as lead/tin alloys, shall not be used for pipe connections or any other refrigerant pressure containing purposes.

Compliance is checked by inspection.

22.115 The **refrigerant charge** (m_c) in each **refrigerating system** employing **flammable refrigerant** shall not exceed m_3 as defined in Annex GG.

The construction of the **refrigerating system** using **flammable refrigerants** shall comply with the requirements in Annex GG.

Compliance is checked by inspection.

22.116 For arcs and sparks from electric components:

22.116.1 Appliances using **flammable refrigerants** shall be constructed so that any leaked refrigerant will not flow or stagnate so as to cause a fire or explosion hazard in areas within the appliance or connected ducts where electrical components, which could be a source of ignition and which could function during **normal operation** or as a result of a leak, are located.

NOTE **Thermal cut-outs** and similar devices are not considered to function during **normal operation**.

Separate components, such as **thermostats**, which are charged with less than 0,5 g of a flammable gas are not considered to cause a fire or explosion hazard in the event of leakage of the gas within the component itself.

*Electrical components, which are potential ignition sources that could function under **normal operation** or as a result of a leak, are not considered a source of ignition if they comply with at least one of the following requirements:*

- a) not be located in an area where a potentially flammable gas mixture will accumulate as demonstrated by the test of Annex FF;
- b) *have equipment protection level according to 22.116.2;*
- c) *are sealed components in compliance with the tests of 22.116.3, and protected from impact by the appliance enclosure;*
- d) *are located in an enclosure which complies with IEC 60079-15:2017, Clause 7 through Clause 10, for restricted breathing enclosures suitable for use with group IIA gases or the refrigerant used;*
- e) *are located in an enclosure which complies with Annex NN. Applicable to appliances with **A2L refrigerants** only;*
- f) *are in compliance with Annex JJ. Applicable to appliance with **A2L refrigerants** only;*
- g) *are in compliance with 22.116.4. Applicable to appliance with **A2L refrigerants** only;*
- h) *electrostatic air cleaners or similar devices tested and found to comply with 22.116.5. Applicable to appliance with **A2L refrigerants** only;*
- i) **refrigerant sensors** tested and found to comply with IEC TS 63542:2024.

22.116.2 Components are not considered to be ignition sources if they comply with the requirements for equipment protection level Ga, Gb, or Gc as defined in IEC 60079-14 for the refrigerant used in the appliance or the relevant gas group (IIA, IIB, or IIC) to which the refrigerant belongs. However, the following requirements do not apply:

- marking requirements of the applicable standard in IEC 60079 (all parts);
- the impact tests of IEC 60079-0;
- the IP test of IEC 60079-0;
- the drop test of IEC 60079-0;
- the creepage and **clearance** requirements in IEC 60079-7.

NOTE 1 Most refrigerants belong to group IIA gases, however R-E170 belongs to group IIB gases.

NOTE 2 Examples of relevant protection principles that can be applied:

- Non incensive components "nC" in IEC 60079-15:2017.
- Flameproof "dc" in IEC 60079-1:2014 (formerly enclosed break device "nC" in IEC 60079-15:2010).
- Increased safety "ec" in IEC 60079-7:2015 and IEC 60079-7:2015/AMD1:2017 (formerly non sparking low power equipment "nA" in IEC 60079-15:2010).

- Intrinsic safety "ic" in IEC 60079-11:2011 (formerly energy limited apparatus "nL" in IEC 60079-15:2010).
- Sealed device "nC" in IEC 60079-15:2017.
- Hermetically sealed device "nC" in IEC 60079-15:2017.
- Restricted breathing enclosure "nR" in IEC 60079-15:2017.

Compliance is checked by inspection or testing as required by the relevant IEC 60079 series standard.

22.116.3 Three samples of the component shall be conditioned in a climate chamber for 168 h at the maximum operating temperature during the test of Clause 11 plus 12 K, but not less than 75 °C. This conditioning is followed by 24 h at the minimum operating temperature during the test of Clause 11 reduced by at least 5 K.

The test temperature in the climate chamber shall be maintained within 2 K for the duration of the test.

The components shall be stabilized at a temperature of 25 °C. The entire components shall then be rapidly immersed in water at a temperature of (50 ± 2) °C to a depth of at least 25 mm below the surface for at least 60 s.

No bubbles shall emerge from the inside of the samples during this test.

22.116.4 For **A2L refrigerants**, devices capable of 100 000 cycles according to Clause 24 switching AC loads in compliance with one of the following are not considered a potential ignition source:

- for resistive loads where the impedance has a power factor higher than 0,99: Breaking current per contact is not more than 48 A during **normal operation**;
- for inductive loads where the power factor is not more than 0,99, the apparent power (S) of the switched inductive electrical load per phase in kVA is less than or equal to:

- $L_e = 5 \times (6,7/S_u)^4$ when breaking all phases of a 3 phase load;
- $L_e = 2,5 \times (6,7/S_u)^4$ all others.

where

L_e is the maximum allowed apparent power of the switched inductive electrical load in kilovoltamperes (kVA);

S_u is the burning velocity of a refrigerant in centimetres per second (cm/s).

Compliance is checked by measurement.

22.116.5 For appliances with **A2L refrigerants**, electrostatic air cleaners and similar devices which can produce electrical arcing during **normal operation** that could ignite the refrigerant used, and which are installed in the unit airstream or connecting ducts, are not considered as a potential ignition source if the airflow is monitored and the energy source of the electric arcing is switched off when the airflow is below the minimum airflow according to Clause GG.9.

Compliance is checked by inspection and, if necessary, by an appropriate test.

22.116.6 For the purpose of determining the maximum quenching diameter (d_q) in Annex JJ and the maximum switched inductive electrical load L_e (see 22.116.4), the effect of humidity on burning velocity (S_u) shall be taken into consideration.

The burning velocity (S_u) shall be the highest value of

- as specified in ISO 817; or

- as measured in humid air at $27\text{ °C} \pm 0,5\text{ °C}$ dew point at 101,3 kPa containing $21,0\% \pm 0,1\%$ O_2 excluding water vapour determined at the nominal composition as specified in ISO 817.

NOTE The 27 °C dew point equates to an absolute humidity of 0,022 7 kg water vapour per 1 kg dry air.

This test can be done at the temperature higher than 27 °C . The required dew point is only for humidity.

The burning velocity (S_u) at 27 °C dew point may be determined by extrapolation of the measurement at 23 °C and 50 % relative humidity and the burning velocity (S_u) as provided by ISO 817. The extrapolation shall be based on the measured value increased by the measurement uncertainty to the burning velocity (S_u) at 23 °C and 50 % relative humidity. If the burning velocity (S_u) is not measurable at dry condition, the burning velocity shall be measured at 27 °C dew point.

22.117 For hot surfaces:

22.117.1 Temperatures on surfaces that can be exposed to leakage of **flammable refrigerants** in excess of 25 % of **LFL** as determined in Annex FF shall not exceed the maximum allowable surface temperature given in Annex BB.

For A2 and A3 refrigerants not listed in Annex BB, the maximum allowable surface temperature is the **AIT**.

For **A2L refrigerants** not listed in Annex BB, the maximum allowable surface temperature is determined by the higher of **AIT** or, if tested per Annex KK, the **hot surface ignition temperature** reduced by 100 K.

*Compliance is checked by measuring the appropriate surface temperatures during the tests of Clause 11 and Clause 19, except those which during the tests of Clause 19 are terminated in a non- self-resetting way. Compliance for **A2L refrigerants** is checked by measuring the appropriate surface temperatures during the tests of Clause 11.*

Surfaces in compliance with 22.117 shall not be considered a potential ignition source.

Refrigerant sensors tested and found to comply with IEC TS 63542:2024 are considered to comply with 22.117.

22.117.2 Temperatures on surfaces that can be exposed to leakage of **A2L refrigerants** may exceed the maximum allowable surface temperature in case of loss of airflow when all the following applies:

- the temperatures are not exceeding the maximum allowable surface temperature with the minimum airflow;
- the airflow is supervised and the heat source of the hot surface is switched off, when the airflow is below the minimum airflow.

NOTE Proof of airflow can be provided by any reliable means, including detection of fan speed.

Compliance is checked by inspection and by measuring the appropriate surface temperatures during the tests of Clause 11.

22.117.3 Open sources of ignition, including open flames, pilot flames, direct spark ignition or hot surface ignition or other similar sources of ignition in the combustion air-stream, if the combustion air is drawn from an unventilated space in which leaked refrigerant can enter through the combustion air intake, are allowed, when these appliances are provided with a flame arrestor or equivalent to ensure that in the event of an ignition, the flame will not propagate.

Compliance is checked by inspection.

22.118 Joints made in the installation between parts of the **refrigerating system**, with at least one part charged, shall be made in accordance with the following.

- A brazed, welded, or mechanical connection shall be made before opening the valves to permit refrigerant to flow between the **refrigerating system** parts. A vacuum valve shall be provided to evacuate the interconnecting pipe and/or any uncharged **refrigerating system** part.
- Mechanical connectors used indoors shall comply with ISO 14903. When mechanical connectors are reused indoors, sealing parts shall be renewed. When flared joints are reused indoors, the flare part shall be re-fabricated.
- Refrigerant tubing shall be protected or enclosed to avoid damage.

Flexible refrigerant connectors (such as connecting lines between the indoor and outdoor unit) that can be displaced during **normal operation** shall be protected against mechanical damage.

Compliance is checked according to the installation instructions and a trial installation if necessary.

22.119 **Condensing units** and **evaporating units** shall be equipped with a **pressure-limiting device** or equivalent to ensure that the equipment does not exceed the **maximum allowable pressure**.

NOTE Applies to **partial unit** types, **condensing units** and **evaporating units** only.

For **partial units**, the interconnection circuits for signal communication between each unit shall be of the same type.

SELV connection is recommended.

Compliance is checked by inspection.

22.120 **Partial units** shall be provided with a means of connection to the supply mains and shall not be powered by an electrical circuit from another appliance.

Compliance is checked by inspection.

22.121 For **leak detection system** sensor location:

22.121.1 For the installation condition of appliances using an **A2L refrigerant** and where a **leak detection system** is applied to fulfil the requirements of Annex GG or for the purpose of limiting **releasable charge**, the **refrigerant sensor** shall be:

- within the unit for appliances connected via an air duct system to one or more rooms,
- within the ventilated enclosure if in compliance with Clause GG.4,
- within the unit where release height h_0 as determined in Clause GG.2 is not more than 1,5 m,
- where the release height h_0 as determined in Clause GG.2 is more than 1,5 m, located within

- the unit, or
- 100 mm or less directly below the unit, or
- remote located within 300 mm above the floor. If a remote located **refrigerant sensor** is specified by the manufacturer, the instructions shall state that the **refrigerant sensor** shall be located within

- i) 10 m horizontal distance in line sight of the unit and on a wall within the room in which the unit is installed, or

- ii) 7 m, if not in line sight of the unit, and on a wall within the room in which the unit is installed. The distance from the unit to the **refrigerant sensor** shall be measured as the shortest horizontal unobstructed path between the unit and the nearest **refrigerant sensor**.

For installations with field applied mechanical joints which are exposed in the occupied space, the instructions shall state that a **refrigerant sensor** shall be

- remote located within 2 m horizontal distance in line of sight of the unit and on a wall within the room in which the unit is installed; and
 - 100 mm above the floor where h_0 is not more than 300 mm from the floor; or
 - 300 mm above the floor where h_0 is greater than 300 mm from the floor.

The following field mechanical joints shall not require a **refrigerant sensor**:

- mechanical joints in compliance with ISO 14903;
- joints in enclosures which vent to the unit or to the outside;
- joints in enclosures which vent to a room with a minimum room area as specified in GG.2.1.

NOTE 1 A single **refrigerant sensor** can be used if it satisfies all of the requirements for the unit and the field applied joints.

NOTE 2 The appliance can have several **refrigerant sensors** in different locations to comply with this standard.

*Compliance is checked by inspection and by testing in accordance with Annex MM or Annex PP. Testing according to Annex MM and Annex PP is not required when the **leak detection system** is only used for reducing the **releasable charge** as determined by Annex QQ. Remote located **refrigerant sensor** location is not tested. **Refrigerant sensors** located 100 mm or less directly below the unit are not considered remote **refrigerant sensors**.*

NOTE 3 Subclause QQ.5.1 specifies when Annex MM or Annex PP are applicable for Clause QQ.3 and Clause QQ.4.

22.121.2 For the installation condition of appliances using an A2 or A3 refrigerant and where a **leak detection system** is applied to fulfil the requirements of Annex GG or for the purpose of limiting **releasable charge**, the **refrigerant sensor** shall be within or part of the unit.

For appliances with ventilated enclosure in compliance with Clause GG.4, the **refrigerant sensor** shall be within the ventilated enclosure.

NOTE More than one **refrigerant sensor** can be used to comply with the requirements of Annex GG.

*Compliance of **leak detection system refrigerant sensor** location is checked by inspection and by testing in accordance with Annex PP. Testing according to Annex PP is not required when the **leak detection system** is only used for reducing the **releasable charge** and the appliance has been tested for compliance with Annex QQ.*

For installations with field applied joints which are exposed in the occupied space, these joints shall require at least one of the following:

- mechanical joints in compliance with ISO 14903;
- welded or brazed joints;
- joints in enclosures which vent to the unit or to the outside.

Compliance is checked by inspection and tests.

22.122 For **refrigerant detection systems** that are required by this standard for **flammable refrigerants**, the following applies:

- the output signal of the **refrigerant detection system** shall activate the actions required to comply with Annex GG in the event of a leak;
- where a **refrigerant detection system refrigerant sensor** is used to activate safety measures in multiple units in the same room, all of the detection system activated safety measures shall be applied to those units in the room which rely on that **refrigerant detection system**;
- if a **refrigerant detection system** or appliance provides notification that replacement of the **refrigerant sensor** is required (see IEC TS 63542:2024), then the user shall be notified and resetting this notification shall only be possible when the **refrigerant sensor** has been replaced.

Refrigerant detection system shall comply with IEC TS 63542:2024.

Compliance is checked by inspection and tests according to IEC TS 63542:2024.

22.123 For appliances using a **flammable refrigerant** according to Clause GG.9, which include a separate section with refrigerant containing components except pipes (e.g. compressors, **condensers**), and is located in a room smaller than 4 m^3 per Clause GG.2, that section shall:

- not be isolated from the indoor air stream, where a leak will be detected, or
- be ventilated to the outdoors in compliance with Clause GG.4, or
- be naturally ventilated to outdoors.

Compliance is checked by inspection.

22.124 Void

22.125 Refrigerating systems that fulfil all of the following conditions may be considered **enhanced tightness refrigerating systems**:

- a) Compressors, pressure relief devices and pressure vessels of the refrigerating system shall be located in locations other than the occupied space.
- b) **Refrigerant distribution assemblies** shall meet all applicable requirements of this standard.
- c) **Refrigerating systems** shall use only permanent joints indoors except for site-made joints directly connecting the indoor unit to the refrigerant piping, or factory-made mechanical joints in compliance with ISO 14903.
- d) Refrigerant containing parts in indoor units shall be protected from damage in the event of catastrophic failure of moving parts, e.g. fans, belts.
- e) Refrigerant containing pipes in the occupied space in question are installed in such a way that they are protected against accidental damage.
- f) The **refrigerating system** of each indoor unit shall be tightness tested at the factory with detection equipment with a capability of 3 grams per year of refrigerant or less under a pressure of at least 0,25 times the **maximum allowable pressure**. No leak shall be detected.

Compliance for bullet a) to bullet f) is checked by inspection.

- g) Vibrations exceeding 0,30 G RMS, when measured with a low pass filter at 200 Hz, are not allowed in the refrigerant containing parts in the occupied space under **normal operation**.

Compliance is checked by testing:

The equipment shall be mounted per installation instructions. The outdoor unit shall be directly connected to the indoor unit by the shortest line set per the installation instructions. Testing shall be conducted in fan only mode, heating mode and cooling mode if applicable.

Vibration level shall be measured over the full range of the compressor and indoor fan speeds as allowed by the controls in consideration of the operation modes. Care shall be taken that the measurement sensors do not influence the line vibration level, and that the rate of change of speed is sufficiently slow that the maximum vibration is captured.

h) **Indoor heat exchangers** shall be protected from damage in the event of freezing.

Compliance is checked as follows:

- *Coils protected by controls. Compliance is checked by inspection; if in doubt, the test for non-freezing coils shall be executed.*
- *Non-freezing coils. Compliance is checked by conducting the minimum cooling performance test as described in ISO 5151, ISO 13253, ISO 15042, or the ISO 13256 series.*
- *Freezing coils. Compliance is checked on 3 samples by testing as follows. Cycling testing of the **heat exchanger** under frosting conditions confirms that the **heat exchanger** has adequate strength to withstand freezing without failure. The appliance shall cycle as intended by the controls for 10 days. At the end of the test, the **heat exchanger** shall withstand the strength requirements of Annex EE.*

i) The maximum speed of the indoor fan, in **normal operation**, shall be less than 90 % of the maximum allowable fan speed as specified by the manufacturer of the fan wheel. If the manufacturer does not specify a maximum allowable fan speed, then the fan wheel shall be tested as follows:

The maximum allowable fan speed shall be established by running continuously at 120 % of maximum speed for 10 days. There shall be no structural failure of the fan.

If non-metallic fan wheels have a minimum thermal index rating of 65 °C per ISO 2578, preconditioning is not required.

If no thermal index rating for the material is available, specimens shall be aged at 90 °C for 168 h. The samples shall not have more than a 50 % reduction of the unconditioned property values for items 1) to 4) below:

- 1) tensile strength in accordance with ISO 527-3,
- 2) flexural strength in accordance with ISO 178,
- 3) Izod impact in accordance with ISO 180,
- 4) tensile impact in accordance with ISO 8256.

Compliance is checked by inspection and testing.

22.126 For the purpose of this standard, **UV-C germicidal lamp systems** are limited to low pressure mercury lamps with a quartz envelope having a continuous spectral irradiance at 254 nm.

NOTE The quartz envelope blocks the 185 nm resonant wavelength for mercury that can generate ozone.

Compliance is checked by inspection.

22.127 The appliance enclosure, **UV-C lamps** and **UV-C barriers** shall be located in such a manner that the **UV-C spectral irradiance** is not emitted outside the unit into an occupied space at a level exceeding the irradiance limit specified in 32.101.1.

Compliance is checked by inspection and test per 32.101.

*The appliance indoor airflow inlet and outlet shall be considered as possible radiation paths. The unit filters are not considered **UV-C barriers**.*

22.128 For appliances that employ **UV-C germicidal lamp systems** and which have doors and/or panels that provide direct access to an area within the appliance where the measured **UV-C spectral irradiance** is greater than 1,7 µW/cm², the doors and/or panels shall be equipped with an interlock device that terminates the power to the lamps when opened.

Compliance is checked by inspection, manual test, and test per 32.101.

*If a switch is used to de-energize the **UV-C lamps** so as to meet the requirement, it shall not be possible to operate the switch with test probe B of IEC 61032.*

22.129 For **user maintenance** access areas, the **UV-C spectral irradiance** shall not exceed the limit specified in 32.101.2 with the access panels opened or removed as needed to perform the required **user maintenance**. Panels that are opened or removed to perform **user maintenance** shall be required to be closed or put back in place for proper operation of the appliance.

Compliance is checked by inspection and test per 32.101.

22.130 If the replacement of the **UV-C lamp** is allowed by the user, the appliance shall be constructed so that

- the replacement of the **UV-C lamp** is easily possible;
- if screws or components are omitted or incorrectly positioned or fastened, the appliance is rendered inoperable or manifestly incomplete.

Compliance is checked by inspection.

22.131 Appliances that employ refrigerants in a **transcritical refrigerating system** shall be equipped with a **pressure-limiting device** that operates no greater than the **maximum allowable pressure** taking into account the tolerance of the **pressure-limiting device**.

Compliance is checked by inspection.

22.132 **Safety shut-off valves** for **flammable refrigerants** for the purposes of limiting the **releasable charge** shall default to fully closed position when the appliance is de-energised for any reason other than failure of the supply mains.

NOTE 1 If the appliance is powered through a **supply cord** fitted with a plug, then disconnecting this plug is not considered a failure of the supply mains.

NOTE 2 Backup power can be utilized to close motor driven valves, for instance capacitors or batteries.

Safety shut-off valves that are activated by a **leak detection system** shall have either

- manual operation for resetting which requires the aid of a **tool**, or
- automatically reset after the **leak detection system** has not detected refrigerant for at least 2 h.

For **refrigerating systems** using A2 or A3 refrigerants, **safety shut-off valves** shall be factory fitted in the appliance.

Compliance is checked by inspection.

The total seat leak rate for the refrigerant used for all the **safety shut-off valves** that reduce the leak into the same space shall be no more than m_{SV} :

$$m_{SV} = 4 \times LFL \quad (102)$$

where

m_{SV} is total seat leak rate in gram per second (g/s);

LFL is the **lower flammability limit** in kilogram per cubic metre (kg/m³);
 4 is a constant.

NOTE 3 m_{SV} is the total leak rate released into the room through the **safety shut-off valves** if there is a leak in the indoor parts.

NOTE 4 The formula for m_{SV} is based on a maximum **refrigerant charge** of m_3 for **refrigerating systems** using **A2L refrigerants** and m_2 for **refrigerating systems** using A2 or A3 refrigerants.

Compliance is checked by the following test.

The **safety shut-off valve** shall be subjected to a cycle test, where it is opened and closed a number of times depending on its intended function:

- a **safety shut-off valve** activating in parallel with compressor cycling: 100 000 cycles;
- a **safety shut-off valve** activating only in response to a **leak detection system** and when appliance is de-energised: 1 000 cycles.

Before and after this cycle test, the seat leakage shall pass the test below, where the leakage rate at each of the tested pressures shall be no more than m_{SV} .

Seat leakage shall be measured, at the valve outlet port at all of the following pressures applied to the valve inlet for 1 min:

- $0,02 \times$ **maximum allowable pressure**;
- $0,5 \times$ **maximum allowable pressure**; and
- $1,0 \times$ **maximum allowable pressure**.

The test shall be performed with refrigerant vapour or other gases with known property.

Equivalent tests, for example an air or a helium leakage test, are permitted, provided it is documented that the tightness test achieves at least the same performance as the test with refrigerant vapour.

The **safety shut-off valves** shall be marked with information for the identification of the valve in case of replacement:

- means for identification of the **safety shut-off valves** for facilitating correct replacement, and
- arrow indicating the direction of flow, when applicable.

Compliance is checked by inspection.

The closing of **safety shut-off valves** in liquid refrigerant lines shall not result in pressures exceeding the **maximum allowable pressure**.

NOTE 5 The purpose is to prevent excessive pressures due to hydraulic shock or trapped liquid refrigerant that could expand when temperature changes.

Compliance is tested by measuring the pressure before and after the valve with a fast response pressure sensor with a time resolution not greater than 0,1 s while opening and closing the valve at the highest liquid refrigerant velocity during **normal operation**.

22.133 Particle foam material shall not be used outdoors without protective cover of metal or rigid plastic material if the appliance is accessible to the general public.

Compliance is checked by inspection and measurement.

22.134 Appliances shall be constructed so that **particle foam material** expanded polypropylene is separated from metallic parts containing cobalt, manganese or copper if operating at a temperature higher than 80 °C.

NOTE Direct contact of expanded polypropylene foam material (material marking according to ISO 1043-1: PP-E) with cobalt, manganese or copper causes degradation of the expanded polypropylene foam material at temperatures above 80 °C.

However, this requirement is not applicable for **particle foam material** parts when a deterioration of 3 mm at the contact point will not cause the appliance to fail to comply with this standard. If the separation is provided by an air gap, it shall be at least 3 mm.

Compliance is checked by inspection and measurement.

22.135 Double wall heat exchangers for **refrigerating systems** employing **flammable refrigerants** with **refrigerant charge** $m_c > m_1$ shall be constructed and connected in a way that they do not allow refrigerants to leak into the secondary circuit if one of the walls breaks.

The intermediate chamber shall be one of the following:

- a) vented to the outdoors;
- b) vented into a room that has equal or larger room area than the required minimum room area determined in Annex GG;
- c) for closed intermediate chamber, monitored to recognize that one of the walls is broken, and if recognize the compressor shall stop.

NOTE This monitoring can be performed by detecting the pressure in the intermediate chamber.

Compliance is checked by inspection for a) and b). For c) the following tests shall be performed

- *by applying the minimum and maximum secondary circuit pressure to the intermediate chamber. The compressor shall stop within 1 min;*
- *by applying the minimum and maximum refrigerant condensing pressure to the intermediate chamber. The compressor shall stop within 1 min.*

23 Internal wiring

23.1 Wireways shall be smooth and free from sharp edges.

Wires shall be protected so that they do not come into contact with burrs, cooling fins or similar edges which may cause damage to their insulation.

Holes in metal through which insulated wires pass shall have smooth well-rounded surfaces or be provided with bushings.

Wiring shall be effectively prevented from coming into contact with moving parts.

Compliance is checked by inspection.

23.2 Beads and similar ceramic insulators on live wires shall be fixed or located so that they cannot change their position or rest on sharp edges. If beads are inside flexible metal conduits, they shall be contained within an insulating sleeve, unless the conduit cannot move in normal use.

Compliance is checked by inspection and by manual test.

23.3 Different parts of an appliance that can move relative to each other in normal use or during **user maintenance** shall not cause undue stress to electrical connections and internal conductors, including those providing earthing continuity. Flexible metallic tubes shall not cause damage to the insulation of the conductors contained within them. Open-coil springs shall not be used to protect the wiring. If a coiled spring, the turns of which touch one another, is used for this purpose, there shall be an adequate insulating lining, such as the sheath of a flexible cord complying with IEC 60227, IEC 60245 or IEC 62821, in addition to the insulation of the conductors.

Compliance is checked by inspection and by the following test.

*If flexing occurs in normal use, the appliance is placed in the normal position of use and is supplied at **rated voltage** and operated under **normal operation**.*

The movable part is moved backwards and forwards, so that the conductor is flexed through the largest angle allowed by the construction, the rate of flexing being 30 per minute. The number of flexings is:

- 10 000, for conductors flexed during normal use;
- 100, for conductors flexed during **user maintenance**.

NOTE A flexing is one movement, either backwards or forwards.

*The appliance shall not be damaged to the extent that compliance with this standard is impaired and it shall be fit for further use. In particular, the wiring and its connections shall withstand the electric strength test of 16.3, the test voltage being reduced to 1 000 V and applied between **live parts** and **accessible metal parts** only. In addition, not more than 10 % of the strands of any conductor of the internal wiring between the main part of the appliance and the movable part shall be broken. However, if the wiring supplies circuits that consume no more than 15 W, then no more than 30 % of the strands shall be broken.*

23.4 Bare internal wiring shall be rigid and fixed so that, in normal use, **clearances** or **creepage distances** cannot be reduced below the values specified in Clause 29.

Compliance is checked during the tests of 29.1 and 29.2.

23.5 A single layer of internal wiring insulation shall not be used to provide **reinforced insulation**.

For **class II construction**, the sheath of a cord complying with IEC 60227 or IEC 60245 or IEC 62821 may provide **supplementary insulation**.

Insulation of single layer internal wiring that is subjected to the supply mains voltage shall withstand the electrical stress likely to occur in normal use.

Compliance is checked by inspection and as follows.

*The insulation of single layer internal wiring shall be electrically equivalent to the **basic insulation** of cords complying with IEC 60227 or IEC 60245 or IEC 62821 or shall comply with the following electric strength test. If the **basic insulation** of the conductor does not fulfil one of these conditions, the conductor is considered to be bare.*

A voltage of 2 000 V is applied for 15 min between the conductor and metal foil wrapped around the insulation. There shall be no breakdown.

23.6 When sleeving is used as **supplementary insulation** on internal wiring, the sleeving shall be retained in position by clamping at both ends or be such that it can only be removed by breaking or cutting.

Compliance is checked by inspection and by manual test.

23.7 Conductors identified by the colour combination green/yellow shall only be used for earthing conductors.

Compliance is checked by inspection.

23.8 Aluminium wires shall not be used for internal wiring.

The requirement does not apply to windings.

Compliance is checked by inspection.

23.9 Stranded conductors shall not be consolidated by soldering where they are subjected to contact pressure, unless the contact pressure is provided by spring terminals.

The requirement does not apply to the soldered tip of a stranded conductor.

Compliance is checked by inspection.

23.10 The insulation and sheath of internal wiring, incorporated in external hoses for the connection of an appliance to the water mains, shall be at least equivalent to that of light polyvinyl chloride sheathed flexible cord (code designation 60227 IEC 52).

Compliance is checked by inspection and by the tests specified in Table 6 of IEC 60227-5:2011 reference numbers 1 and 2.

23.101 Wires shall be protected if they can be damaged by contact with refrigerant piping.

NOTE Refrigerant piping can destroy the cable insulation by relative movement between the pipe and the wire due to vibrations, even when the vibrations are not severe.

Compliance is checked by inspection.

24 Components

24.1 Components shall comply with the safety requirements specified in the relevant IEC standards as far as they reasonably apply.

Compliance with the IEC standard for the relevant component does not necessarily ensure compliance with the requirements of this standard.

Motors are not required to comply with IEC 60034-1. They are tested as part of the appliance according to this standard.

Relays shall be tested as part of the appliance according to this standard. They may be alternatively tested to IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015, in which case they must also meet the additional requirements in IEC 60335-1.

Unless otherwise specified, the requirements of Clause 29 of this standard apply between **live parts** of components and **accessible parts** of the appliance. Unless otherwise specified,

components may comply with the requirements for **clearances** and **creepage distances** for **functional insulation** as specified in the relevant component standard.

Unless otherwise specified, the requirements of 30.2 of this standard apply to parts of non-metallic material in components including parts of non-metallic material supporting current-carrying connections inside components.

Components that have not been previously tested and shown to comply with the IEC standard for the relevant component are tested according to the requirements of 30.2 of this standard.

Components that have been previously tested and shown to comply with the resistance to fire requirements in the IEC standard for the relevant component need not be retested provided that:

- the severity specified in the component standard is not less than the severity specified in 30.2 of this standard, and
- unless the pre-selection alternatives in 30.2 are used, the test report for the component states the values of t_E and t_i as required by IEC 60695-2-11:2014.

If the above two conditions are not satisfied, the component is tested as part of the appliance.

NOTE 1 There are two levels of severity specified for appliances for which 30.2.3 is applicable.

Power electronic converter circuits are not required to comply with IEC 62477-1. They are tested as part of the appliance according to this standard.

Motor-compressors shall:

- comply with IEC 60335-2-34 (including its Annex AA), or
- comply with IEC 60335-2-34 (without Annex AA) and comply with Clause 11 of this standard, or

NOTE 101 The motor-compressor includes its motor-compressor protection and control system used for compliance with IEC 60335-2-34.

- comply with this standard and in addition shall comply with IEC 60335-2-34:2021, 22.9.

Unless components have been previously tested and found to comply with the relevant IEC standard for the number of cycles specified, they are tested in accordance with 24.1.1 to 24.1.9. For components mentioned in 24.1.1 to 24.1.9, no additional tests specified in the relevant IEC standard for the component are necessary other than those specified in 24.1.1 to 24.1.9.

Components that have not been separately tested and found to comply with the relevant IEC standard and components that are not marked or not used in accordance with their marking are tested in accordance with the conditions occurring in the appliance, the number of samples being that required by the relevant standard.

NOTE 2 For automatic controls, marking includes documentation and declaration as specified in Clause 7 of IEC 60730-1:2013/AMD1:2015.

Lampholders and starterholders that have not been previously tested and found to comply with the relevant IEC standard are tested as a part of the appliance and shall additionally comply with the gauging and interchangeability requirements of the relevant IEC standard under the conditions occurring in the appliance. Where the relevant IEC standard specifies these gauging and interchangeability requirements at elevated temperatures, the temperatures measured during the tests of Clause 11 are used.

Unless they are specifically mentioned in the text of this standard, there are no additional tests specified for nationally standardized plugs such as those detailed in IEC TR 60083 or

connectors or plug connectors complying with the standard sheets of IEC 60320-3 or connectors complying with the standard sheets of IEC 60309-2.

When an IEC standard does not exist for a component, there are no additional tests specified.

24.1.1 The relevant standard for capacitors likely to be permanently subjected to the supply voltage and used for radio interference suppression or for voltage dividing is IEC 60384-14:2013 including IEC 60384-14:2013/AMD1:2016.

Capacitors likely to be permanently subjected to the supply voltage are capacitors incorporated in appliances:

- for which 30.2.3 is applicable; or
- for which 30.2.2 is applicable, unless the capacitor is disconnected from the supply mains by an on-off switch. This switch shall provide **all-pole disconnection** if the capacitor is connected to earth.

If the capacitors have to be tested, they are tested in accordance with normative Annex F.

24.1.2 The relevant standard for transformers in associated switch mode power supplies is Annex BB of IEC 61558-2-16:2009 including IEC 61558-2-16:2009/AMD1:2013. Clause 26 of IEC 61558-1:2017 and Annex H of IEC 61558-1:2017 are not applicable.

The relevant standard for **safety isolating transformers** is IEC 61558-2-6:2009. If they have to be tested, they are tested in accordance with normative Annex G.

24.1.3 The relevant standard for switches is IEC 61058-1:2016. The number of cycles of operation declared for 7.4 of IEC 61058-1:2016 shall be at least 10 000. If they have to be tested, they are tested in accordance with normative Annex H.

The number of operating cycles for switches need not be declared for 7.4 if the appliance meets the requirements of this standard when they are rendered inoperative.

If the switch operates a relay or contactor, the complete switching system is subjected to the test.

If the switch only operates a motor starting relay complying with IEC 60730-2-10 with the number of cycles of operation declared for 6.10 and 6.11 of IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015 of at least 10 000 cycles, the complete switching system need not be tested.

24.1.4 The relevant standard for automatic controls is IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015 together with the relevant part 2.

The number of cycles of operation declared for 6.10 and 6.11 of IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015 shall not be less than the following:

– thermostats	10 000
– temperature limiters	1 000
– self-resetting thermal cut-outs	300
– voltage-maintained non-self-resetting thermal cut-outs	1 000
– other non-self-resetting thermal cut-outs	30
– timers	3 000
– energy regulators	10 000
– self-resetting thermal cut-outs	3 000

– other non-self-resetting thermal cut-outs	300
– thermostats which control the motor-compressor	100 000
– motor-compressor starting relays	100 000
– automatic thermal motor-protectors for motor-compressors of the hermetic and semi-hermetic type	min. 2 000 (but not less than the number of operations during the locked rotor test)
– manual reset thermal motor-protectors for motor-compressors of the hermetic and semi-hermetic type	50
– other automatic thermal motor protectors	2 000
– other manual reset thermal motor protectors	30
– refrigerant detection systems self-resetting	300
– refrigerant detection systems non-self-resetting	30
– electromechanical proof of airflow control	100 000
– self-resetting electrical pressure-limiting device	3 000
– non-self-resetting electrical pressure-limiting device	300

The number of cycles of operation for automatic controls that operate during the test of Clause 11 need not be declared for 6.10 and 6.11 of IEC 60730-1, if the appliance meets the requirements of this standard when they are short-circuited or rendered inoperative.

If automatic controls have to be tested, they are also tested in accordance with Subclauses 11.3.5 to 11.3.8 and Clause 17 of IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015 as type 1 controls. The tests of Clauses 12, 13 and 14 of IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015 are not carried out before carrying out the test of Clause 17.

The ambient temperature during the test of Clause 17 of IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015 is that occurring during the test of Clause 11 in the appliance, as specified in footnote b of Table 3.

Thermal motor protectors are tested in combination with their motor under the conditions specified in normative Annex D.

For water valves containing **live parts** and that are incorporated in external hoses for connection of an appliance to the water mains, the degree of protection provided by enclosures against harmful ingress of water declared for Subclause 6.5.2 of IEC 60730-2-8:2018 shall be IPX7.

Thermal cut-outs of the capillary type shall comply with the requirements for type 2.K controls in IEC 60730-2-9:2015 including IEC 60730-2-9:2015/AMD1:2018.

24.1.5 The relevant standard for appliance couplers is IEC 60320-1. However, for appliances classified higher than IPX0, the relevant standard is IEC 60320-2-3.

24.1.6 The relevant standard for small lampholders similar to E10 lampholders is IEC 60238, the requirements for E10 lampholders being applicable. However, they need not accept a lamp with an E10 cap complying with the current edition of standard sheet 7004-22 of IEC 60061-1.

24.1.7 If the **remote operation** of the appliance is via a telecommunication network, the relevant standard for the telecommunication interface circuitry in the appliance is IEC 62151.

24.1.8 The relevant standard for **thermal links** is IEC 60691. **Thermal links** that do not comply with IEC 60691 are considered to be an **intentionally weak part** for the purposes of Clause 19.

24.1.9 Contactors and relays, other than motor starting relays, are tested as part of the appliance. However, they are also tested in accordance with Clause 17 of IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015 under the maximum load conditions occurring in the appliance for at least the number of cycles of operation in 24.1.4 selected according to the contactor or relay function in the appliance.

24.1.10 Lamps and lamp systems that have not been previously tested and found to comply with the exempt group classification of IEC 62471:2006 general lighting systems (GLS) regarding actinic ultraviolet hazard (E_S) and near-UV hazard (E_{UVA}) are tested as a part of the appliance and shall comply with the requirements of Clause 32 under the conditions occurring in the appliance.

Unless otherwise specified, the following components are considered to comply with the exempt group classification of IEC 62471:2006 regarding actinic ultraviolet hazard (E_S) and near-UV hazard (E_{UVA}):

- visible light indicators;
- infrared sources used for signalling or communication;
- seven-segment indicators;
- liquid-crystal displays;
- organic LED displays (OLED);
- plasma displays.

24.1.11 For cord sets required to be provided with the appliance, the relevant standard is IEC 60799. Cord sets with cords complying to IEC 62821-3 are allowed.

24.2 Appliances shall not be fitted with:

- switches, automatic controls, power supplies and the like in flexible cords;
- devices that cause the **protective device** in the fixed wiring to operate in the event of a fault in the appliance;
- **thermal cut-outs** that can be reset by a soldering operation, unless the solder has a melting point of at least 230 °C.

Compliance is checked by inspection.

24.3 Switches intended to ensure **all-pole disconnection** of **stationary appliances**, as required in 22.2, shall be directly connected to the supply terminals and shall have a contact separation in all poles, providing full disconnection under overvoltage category III conditions.

NOTE 1 Full disconnection is contact separation of a pole to ensure the equivalent of **basic insulation**, in accordance with IEC 61058-1:2016, between the supply mains and those parts that are intended to be disconnected.

NOTE 2 **Rated impulse voltages** for overvoltage categories are given in Table 15.

Compliance is checked by inspection and by measurement.

24.4 Plugs and socket-outlets for **extra-low voltage** circuits, and those used as terminal devices for heating elements, shall not be interchangeable with plugs and socket-outlets listed in IEC TR 60083 or IEC 60906-1 or with connectors, appliance inlets, plug connectors and appliance outlets complying with the standard sheets of IEC 60320-3.

Compliance is checked by inspection.

24.5 Capacitors in auxiliary windings of motors shall be marked with their voltage rating and their rated capacitance and shall be used in accordance with these markings.

*Compliance is checked by inspection and by the appropriate tests. In addition, for capacitors connected in series with a motor winding, it is verified that, when the appliance is supplied at 1,1 times **rated voltage** and under minimum load, the voltage across the capacitor does not exceed 1,1 times its voltage rating.*

24.6 The **working voltage** of motors directly connected to the supply mains and having **basic insulation** that is inadequate for the **rated voltage** of the appliance, shall not exceed 42 V. In addition, they shall comply with the requirements of normative Annex I.

Compliance is checked by measurement and by the tests of normative Annex I.

24.7 Detachable hose-sets for the connection of appliances to the water mains shall comply with IEC 61770. They shall be supplied with the appliance.

Appliances intended to be permanently connected to the water mains shall not be connected by a **detachable hose-set**.

NOTE Examples of appliances that are considered not intended to be permanently connected to the water mains are household appliances such as dishwashers, washing machines, tumble dryers, refrigerators, icemakers, steam ovens and the like.

Compliance is checked by inspection.

24.8 Motor running capacitors in appliances for which 30.2.3 is applicable and that are permanently connected in series with a motor winding shall not cause a hazard in the event of a capacitor failure.

The requirement is considered to be met by one or more of the following conditions:

- the capacitors are of class of safety protection S2 or S3 according to IEC 60252-1:2010 including IEC 60252-1:2010/AMD1:2013;
- the capacitors are housed within a metallic or ceramic enclosure that will prevent the emission of flame or molten material resulting from failure of the capacitor;

NOTE The enclosure can have an entry or exit hole for the wiring connecting the capacitor to the motor.

- the distance of separation of the outer surface of the capacitor to adjacent non-metallic parts exceeds 50 mm;
- adjacent non-metallic parts within 50 mm of the outer surface of the capacitor withstand the needle-flame test of normative Annex E;
- adjacent non-metallic parts within 50 mm of the outer surface of the capacitor are classified as at least V-1 according to IEC 60695-11-10, provided that the test sample used for the classification was no thicker than the relevant part of the appliance.

For capacitors complying with IEC 60252-1:2010 including IEC 60252-1:2010/AMD1:2013, the damp heat test severity parameters for 5.14 of IEC 60252-1:2010 including IEC 60252-1:2010/AMD1:2013 shall be:

- temperature $40\text{ }^{\circ}\text{C} \pm 2\text{ }^{\circ}\text{C}$ at a relative humidity of $93\% \pm 3\%$;
- duration 21 days.

Compliance is checked by inspection, measurement or the appropriate flammability requirement.

24.101 Thermal control devices incorporating replaceable parts shall be marked in such a way that the replaceable parts can be identified.

The replacement part shall be marked accordingly.

Compliance is checked by inspection of the marking.

24.102 The **pressure-limiting devices** used in **transcritical refrigerating systems** shall comply with IEC 60730-2-6 and

- shall be of type 2.A or 2.B;
- shall have a trip free mechanism of type 2.J;
- the deviation and drift shall not exceed $+ 0\%$.

Compliance is checked by inspection.

25 Supply connection and external flexible cords

25.1 Appliances, other than those intended to be permanently connected to fixed wiring, shall be provided with one of the following means for connection to the supply mains:

- **supply cord** fitted with a plug, the current rating and voltage rating of the plug being not less than the corresponding ratings of its associated appliance;
- an appliance inlet having at least the same degree of protection against moisture as required for the appliance;
- pins for insertion into socket-outlets.

Appliances may be provided with a **supply cord** fitted with a plug

- if the **supply cord** with a plug is for indoor use only,
- if they have a marked rating of 25 A or less, and
- if they comply with the applicable code requirements for cord-connected appliances appropriate to the specific country in which they are to be used.

Compliance is checked by inspection.

Modification:

Appliances shall not be provided with an appliance inlet.

25.2 Appliances, other than **stationary appliances** for multiple supply, shall not be provided with more than one means of connection to the supply mains. **Stationary appliances** for multiple supply may be provided with more than one means of connection provided that the relevant circuits are adequately insulated from each other.

NOTE 1 For example, a multiple supply may be required for appliances supplied with day and night tariffs.

Compliance is checked by inspection and by the following test.

A voltage of 1 250 V of substantially sinusoidal waveform and having a frequency of 50 Hz or 60 Hz is applied for 1 min between each means of connection to the supply mains.

NOTE 2 This test can be combined with that of 16.3.

During this test, no breakdown shall occur.

25.3 Appliances intended to be permanently connected to fixed wiring shall be provided with one of the following means for connection to the supply mains:

- cord anchorage and a set of terminals allowing the connection of a flexible cord;
- a fitted **supply cord**;
- a set of **supply leads** accommodated in a suitable compartment;
- a set of terminals allowing the connection of cables of fixed wiring having the nominal cross-sectional areas specified in 26.6;
- a set of terminals and cable entries, conduit entries, knock-outs or glands, which allow the connection of the appropriate types of cable or conduit.

Appliances intended to be permanently connected to fixed wiring that are provided with:

- a set of terminals allowing the connection of cables of fixed wiring having the nominal cross-sectional areas specified in 26.6; or
- a set of terminals and cable entries, conduit entries, knock-outs or glands, which allow the connection of the appropriate types of cable or conduit

shall allow the connection of the supply conductors after the appliance has been fixed to its support.

If a **fixed appliance** is constructed so that parts can be removed to facilitate easy installation, this requirement is considered to be met if it is possible to connect the fixed wiring without difficulty after a part of the appliance has been fixed to its support. In this case, removable parts are to be constructed for ease of reassembly without risk of incorrect assembly or damage to the wiring or terminals.

Compliance is checked by inspection and, if necessary, by making the appropriate connections.

25.4 For appliances intended to be permanently connected to the fixed wiring and having a **rated current** not exceeding 16 A, cable and conduit entries shall be suitable for cables or conduits having a maximum overall dimension shown in Table 10.

Table 10 – Dimensions of cables and conduits

Number of conductors including earthing conductors	Maximum overall dimension mm	
	Cable	Conduit ^a
2	13,0	16,0 (23,0)
3	14,0	16,0 (23,0)
4	14,5	20,0 (23,0)
5	15,5	20,0 (29,0)
^a The dimensions in parentheses are for use in USA and Canada.		

Conduit entries, cable entries and knock-outs shall be constructed or located so that the introduction of the conduit or cable does not reduce **clearances** or **creepage distances** below the values specified in Clause 29.

Compliance is checked by inspection and by measurement.

25.5 Supply cords shall be assembled to the appliance by one of the following methods:

- **type X attachment**;
- **type Y attachment**;
- **type Z attachment**, if allowed in the relevant part 2.

Type X attachments, other than those having a specially prepared cord, shall not be used for flat twin tinsel cords.

For multi-phase appliances that are supplied with a **supply cord** and that are intended to be permanently connected to the fixed wiring, the **supply cord** shall be assembled to the appliance by a **type Y attachment**.

Compliance is checked by inspection.

25.6 Plugs shall not be fitted with more than one flexible cord.

Compliance is checked by inspection.

25.7 Supply cords for appliances other than **class III appliances** shall be one of the following types:

- Rubber sheathed
Their properties shall be at least those of ordinary tough rubber sheathed cords (code designation 60245 IEC 53).
These **supply cords** shall not be used on appliances intended to be used outdoors or when they are liable to be exposed to significant amounts of ultraviolet radiation.
- Polychloroprene sheathed
Their properties shall be at least those of ordinary polychloroprene sheathed cords (code designation 60245 IEC 57).
These **supply cords** may be connected to appliances intended to be used in low temperature applications.
- Polyvinyl chloride sheathed
These **supply cords** shall not be used if they are likely to touch metal parts having a temperature rise exceeding 75 K during the test of Clause 11. Their properties shall be at least those of:
 - light polyvinyl chloride sheathed cord (code designation 60227 IEC 52), for appliances having a mass not exceeding 3 kg;
 - ordinary polyvinyl chloride sheathed cord (code designation 60227 IEC 53), for other appliances.
- Heat resistant polyvinyl chloride sheathed
These **supply cords** shall not be used for **type X attachment** other than specially prepared cords. Their properties shall be at least those of:
 - heat-resistant light polyvinyl chloride sheathed cord (code designation 60227 IEC 56), for appliances having a mass not exceeding 3 kg;
 - heat-resistant polyvinyl chloride sheathed cord (code designation 60227 IEC 57), for other appliances.

– Halogen-free, low smoke, thermoplastic insulated and sheathed

Their properties should at least be those of:

- light duty halogen-free low smoke flexible cable (code designation 62821 IEC 101 for circular cable and code designation 62821 IEC 101f for flat cable);
- ordinary duty halogen-free, low smoke flexible cable (code designation 62821 IEC 102 for circular cable and code designation 62821 IEC 102f for flat cable).

Supply cords for **class III appliances** shall be adequately insulated.

Supply cords of parts of appliances for outdoor use shall not be lighter than polychloroprene sheathed flexible cord (code designation 60245 IEC 57).

*Compliance is checked by inspection, by measurement, and for **class III appliances** that contain **live parts**, by the following test.*

A voltage of 500 V is applied for 2 min between the conductor and metal foil wrapped around the insulation, the insulation being at the temperature measured during the test of Clause 11. There shall be no breakdown during this test.

25.8 Conductors of **supply cords** shall have a nominal cross-sectional area not less than that shown in Table 11.

Table 11 – Minimum cross-sectional area of conductors

Rated current of appliance A			Nominal cross-sectional area mm ²
		≤0,2	Tinsel cord ^a
>0,2	and	≤2,5	0,5 ^a
>2,5	and	≤6	0,75
>6	and	≤10	1,0 (0,75) ^b
>10	and	≤16	1,5 (1,0) ^b
>16	and	≤25	2,5
>25	and	≤32	4
>32	and	≤40	6
>40	and	≤63	10
NOTE For supply cords supplied with multi-phase appliances, the nominal cross-sectional area of the conductors is based on the maximum cross-sectional area of the conductors per phase at the supply cord connection to the appliance terminals.			
^a These cords may only be used if their nominal length does not exceed 2 m between the point where the cord enters the appliance and the entry to the plug.			
^b Cords having the cross-sectional areas indicated in the parentheses may be used for portable appliances if their length does not exceed 2 m.			

Compliance is checked by measurement.

25.9 **Supply cords** shall not be in contact with sharp points or edges of the appliance.

Compliance is checked by inspection.

25.10 The **supply cord** of **class I appliances** shall have a green/yellow core that is connected to the earthing terminal of the appliance and for appliances not intended for permanent connection to the fixed wiring, to the earthing contact of the plug.

In multi-phase appliances, the colour of the neutral conductor of the **supply cord**, if any, shall be blue.

Where additional neutral conductors are provided in the **supply cord**:

- other colours may be used for these additional neutral conductors;
- all of the neutral conductors and line conductors shall be identified by marking using the alphanumeric notation specified in IEC 60445;
- the **supply cord** shall be fitted to the appliance.

Compliance is checked by inspection.

25.11 Conductors of **supply cords** shall not be consolidated by soldering where they are subjected to contact pressure, unless the contact pressure is provided by spring terminals.

The requirement does not apply to the soldered tip of a stranded conductor.

Compliance is checked by inspection.

25.12 The insulation of the **supply cords** shall not be damaged when moulding the cord to part of the enclosure.

Compliance is checked by inspection.

25.13 Inlet openings for **supply cords** shall be constructed so that the sheath of the **supply cord** can be introduced without risk of damage. If it is not evident from the construction of the appliance that the **supply cord** can be introduced without risk of damage, a **non-detachable lining** or **non-detachable bushing** shall be provided that complies with 29.3 for **supplementary insulation**. If the **supply cord** is unsheathed, a similar additional bushing or lining is required, unless the appliance is a **class 0 appliance** or a **class III appliance** that does not contain **live parts**.

Compliance is checked by inspection.

25.14 Appliances provided with a **supply cord** and that are moved while in operation shall be constructed so that the **supply cord** is adequately protected against excessive flexing where it enters the appliance.

This requirement does not apply to appliances with automatic cord reels that comply with the requirement and test of 22.16.

Compliance is checked by the following test that is carried out on an apparatus having an oscillating member as shown in Figure 8.

*The part of the appliance that includes the inlet opening is fixed to the oscillating member so that, when the **supply cord** is at the middle of its travel, the axis of the cord where it enters the cord guard or inlet is vertical and passes through the axis of oscillation. The major axis of the section of flat cords shall be parallel to the axis of oscillation.*

The cord is loaded so that the force applied is:

- 10 N, for cords having a nominal cross-sectional area exceeding 0,75 mm²;

- 5 N, for other cords.

The distance *X*, as shown in Figure 8, between the axis of oscillation and the point where the cord or cord guard enters the appliance, is adjusted so that when the oscillating member moves over its full range, the cord and load make the minimum lateral movement.

The oscillating member is moved through an angle of 90° (45° on either side of the vertical), the number of flexings for **type Z attachments** being 20 000 and for other attachments 10 000. A flexing is one movement of 90°. The rate of flexing is 60 per minute.

The cord and its associated parts are turned through an angle of 90° after half the number of flexings, unless a flat cord is fitted.

During the test, the conductors are supplied at **rated voltage** and loaded with the **rated current** of the appliance. Current is not passed through the earthing conductor or functional earthing conductor.

The test shall not result in:

- a short circuit between the conductors, such that the current exceeds a value equal to twice the **rated current** of the appliance;
- a breakage of more than 10 % of the strands of any conductor;
- separation of the conductor from its terminal;
- loosening of any cord guard;
- damage to the cord or cord guard which could impair compliance with this standard;
- broken strands piercing the insulation and becoming accessible.

25.15 Appliances provided with a **supply cord**, and appliances intended to be permanently connected to fixed wiring by a flexible cord, shall have a cord anchorage. The cord anchorage shall relieve conductors from strain, including twisting, at the terminals and protect the insulation of the conductors from abrasion.

It shall not be possible to push the cord into the appliance to such an extent that the cord or internal parts of the appliance could be damaged.

Compliance is checked by inspection, by manual test and by the following test.

A mark is made on the cord at a distance of approximately 20 mm from the cord anchorage or other suitable point. The mark is made while the cord is subjected to a pull force of:

- 100 N, for **fixed appliances** regardless of the mass of the appliance;
- the value as shown in Table 12, for other appliances.

The cord is then pulled, without jerking, for 1 s in the most unfavourable direction with the force specified. The test is carried out 25 times.

The cord, unless on an automatic cord reel, is then subjected to a torque that is applied as close as possible to the appliance. The torque is specified in Table 12 and is applied for 1 min.

Table 12 – Pull force and torque

<i>Mass of appliance</i> <i>kg</i>	<i>Pull force</i> <i>N</i>	<i>Torque</i> <i>Nm</i>
≤ 1	30	0,10
$>1 \text{ and } \leq 4$	60	0,25
> 4	100	0,35

During the tests, the cord shall not be damaged and shall show no appreciable strain at the terminals. The pull force is reapplied and the cord shall not be longitudinally displaced by more than 2 mm.

25.16 Cord anchorages for **type X attachments** shall be constructed and located so that:

- replacement of the cord is easily possible;
- it is clear how the relief from strain and the prevention of twisting are obtained;
- they are suitable for the different types of **supply cord** that may be connected, unless the cord is specially prepared;
- the cord cannot touch the clamping screws of the cord anchorage if these screws are accessible, unless they are separated from **accessible metal parts** by **supplementary insulation**;
- the cord is not clamped by a metal screw which bears directly on the cord;
- at least one part of the cord anchorage is securely fixed to the appliance, unless it is part of a specially prepared cord. However, this does not apply if:
 - the cord anchorage comprises one or more clamping members to which pressure is applied by means of nuts engaging with studs that are securely attached to the appliance, even if the clamping member can be removed from the studs;
 - one of the clamping members is fixed to the appliance or the surface of the appliance is of insulating material and shaped so that it is obvious that this surface is one of the clamping members;

NOTE 1 If the pressure on the clamping members is applied by means of one or more screws engaging with separate nuts or with a thread in a part that is integral with the appliance, the cord anchorage is not considered to have one part securely fixed to the appliance.

- screws which have to be operated when replacing the cord do not fix any other component. However, this does not apply if:
 - after removal of the screws, or if the component is incorrectly repositioned, the appliance becomes inoperative or is obviously incomplete;
 - the parts intended to be fastened by them cannot be removed without the aid of a **tool** during the replacement of the cord;
- if labyrinths can be bypassed, the test of 25.15 is nevertheless withstood;
- for **class 0 appliances**, **class 0I appliances** and **class I appliances**, they are of insulating material or are provided with an insulating lining, unless failure of the insulation of the cord does not make **accessible metal parts** live;
- for **class II appliances**, they are of insulating material or, if of metal, they are insulated from **accessible metal parts** by **supplementary insulation**.

NOTE 2 Examples of acceptable and unacceptable constructions of cord anchorages are shown in Figure 9.

Compliance is checked by inspection and by the test of 25.15 under the following conditions.

The tests are carried out with the lightest permissible type of cord of the smallest cross-sectional area specified in Table 13 and then with the next heavier type cord having the largest cross-

sectional area specified. However, if the appliance is fitted with a specially prepared cord, the test is carried out with this cord.

The conductors are placed in the terminals and any terminal screws tightened just sufficiently to prevent the conductors from easily changing their position. The clamping screws of the cord anchorage are tightened with two-thirds of the torque specified in 28.1.

Screws of insulating material bearing directly on the cord are fastened with two-thirds of the torque specified in column I of Table 14, the length of the slot in the screw head being taken as the nominal diameter of the screw.

After the test, the conductors shall not have moved by more than 1 mm in the terminals.

25.17 For **type Y attachment** and **type Z attachment**, cord anchorages shall be adequate.

Compliance is checked by the test of 25.15 with the cord supplied with the appliance.

25.18 Cord anchorages shall be arranged so that they are only accessible with the aid of a **tool** or shall be constructed so that the cord can only be fitted with the aid of a **tool**.

Compliance is checked by inspection.

25.19 For **type X attachment**, glands shall not be used as cord anchorages in **portable appliances**. Tying the cord into a knot or tying the cord with string is not allowed.

Compliance is checked by inspection.

25.20 The conductors of the **supply cord** for **type Y attachment** and **type Z attachment** shall be insulated from **accessible metal parts** by **basic insulation** for **class 0 appliances**, **class 0I appliances** and **class I appliances**, and by **supplementary insulation** for **class II appliances**. This insulation may be provided by the sheath of the **supply cord** or by other means.

Compliance is checked by inspection and by the relevant tests.

25.21 The space for the connection of **supply cords** having **type X attachment**, or for the connection of fixed wiring, shall be constructed:

- so that it is possible to check that the supply conductors are correctly positioned and connected before fitting any cover;
- so that any cover can be fitted without risk of damage to the conductors or their insulation;
- for **portable appliances**, so that the uninsulated end of a conductor, should it become free from the terminal, cannot come into contact with **accessible metal parts**.

Compliance is checked by inspection after fitting cables or flexible cords having the largest cross-sectional area specified in Table 13.

Portable appliances are subjected to the following additional test unless they are provided with pillar terminals and the **supply cord** is clamped within 30 mm of them. The cord anchorage may be used to provide the clamping.

*The clamping screws or nuts are loosened in turn. A force of 2 N is applied to the conductor in any direction at a position adjacent to the terminal. The uninsulated end of the conductor shall not come into contact with **accessible metal parts**.*

25.22 Appliance inlets shall:

- be located or enclosed so that **live parts** are not accessible during insertion or removal of the connector. This requirement is not applicable to appliance inlets complying with IEC 60320-1;
- be located so that the connector can be inserted without difficulty;
- be located so that, after insertion of the connector, the appliance is not supported by the connector when it is placed in any position of normal use on a flat surface;
- not be an appliance inlet for cold conditions if the temperature rise of external metal parts of the appliance exceeds 75 K during the test of Clause 11, unless the flexible cord of the cord set is unlikely to touch such metal parts in normal use.

Compliance is checked by inspection.

25.23 Interconnection cords shall comply with the requirements for the **supply cord**, except that:

- the cross-sectional area of the conductors of the **interconnection cord** is determined on the basis of the maximum current carried by the conductor during the test of Clause 10 and not by the **rated current** of the appliance. If the measured current in the **interconnection cord** is greater than the **rated current** but does not exceed the **rated current** by more than the current deviation in Table 2, the cross-sectional area of the conductors in the **interconnection cord** do not need to be greater than the cross-sectional area of the conductors in the **supply cord**;
- the thickness of the insulation of the conductor may be reduced if the voltage of the conductor is less than the **rated voltage**;
- for **class III construction**, **interconnection cords** of a **class I appliance or class II appliance**, the cross-sectional areas of the conductors need not comply with 25.8 if the temperature of the cord insulation specified in Table 3 and Table 9 are not exceeded during the tests of Clause 11 and Clause 19, respectively.

Compliance is checked by inspection, by measurement and, if necessary, by tests, such as the electric strength test of 16.3.

25.24 Interconnection cords shall not be detachable without the aid of a **tool** if compliance with this standard is impaired when they are disconnected.

Compliance is checked by inspection and if necessary by appropriate tests.

25.25 The dimensions of pins of appliances that are inserted into socket-outlets shall be compatible with the dimensions of the relevant socket-outlet. Dimensions of the pins and engagement face are to be in accordance with the dimensions of the relevant plug listed in IEC TR 60083.

Compliance is checked by measurement.

26 Terminals for external conductors

26.1 Appliances shall be provided with terminals or equally effective devices, such as male tabs of flat quick-connect terminations in accordance with IEC 61210, screw type terminals in accordance with IEC 60998-2-1, screwless terminals in accordance with IEC 60998-2-2 and clamping units in accordance with IEC 60999-1:1999, for the connection of external conductors. The terminals of a component such as a switch may also be used as terminals for external conductors as long as they comply with the requirements of this clause.

The terminals, other than terminals in **class III appliances** that do not contain **live parts**, shall only be accessible after the removal of a **non-detachable cover**. However, earthing terminals

and functional earthing terminals may be accessible if a **tool** is required to make the connections and means are provided to clamp the wire independently from its connection.

Compliance is checked by inspection and by manual test.

26.2 Appliances having **type X attachment**, except those having a specially prepared cord, and appliances for the connection of cables of fixed wiring shall be provided with terminals in which the connections are made by means of screws, nuts or similar devices, unless the connections are soldered.

The screws and nuts shall not be used to fix any other component except that they may also clamp internal conductors if these are arranged so that they are unlikely to be displaced when fitting the supply conductors.

If soldered connections are used, the conductor shall be positioned or fixed so that reliance is not placed upon the soldering alone to maintain it in position. However, soldering alone may be used if barriers are provided so that neither **clearances** nor **creepage distances** between **live parts** and other metal parts can be reduced below the values specified for **supplementary insulation** if the conductor becomes free at the soldered joint.

Compliance is checked by inspection and by measurement.

26.3 Terminals for **type X attachment** and those for the connection of cables of fixed wiring shall be constructed so that they clamp the conductor between metal surfaces with sufficient contact pressure but without causing damage to the conductor.

The terminals shall be fixed so that when the clamping means is tightened or loosened:

- the terminal does not become loose. This does not apply if the terminals are fixed with two screws, or are fixed with one screw in a recess so that there is no appreciable movement or if they are not subject to torsion in normal use and they are locked by a self-hardening resin;
- internal wiring is not subjected to stress;
- neither **clearances** nor **creepage distances** are reduced below the values specified in Clause 29.

Compliance is checked by inspection and by the test of Subclause 9.6 of IEC 60999-1:1999, the torque applied being equal to two-thirds of the torque specified.

After the test, the conductors shall show no deep or sharp indentations.

26.4 Terminals for **type X attachment**, except **type X attachments** having a specially prepared cord, and terminals for the connection of cables of fixed wiring, shall not require special preparation of the conductor such as by soldering of the strands of the conductor, the use of cable lugs, eyelets or similar devices. Reshaping of the conductor before its introduction into the terminal or twisting a stranded conductor to consolidate the end is not considered special preparation.

The terminals shall be constructed or placed so that the conductor cannot slip out when clamping screws or nuts are tightened.

Compliance is checked by inspection of the terminals and conductors after the test of 26.3.

26.5 Terminals for **type X attachment** shall be located or shielded so that if a wire of a stranded conductor escapes when the conductors are fitted, there is no risk of accidental connection to other parts that could result in a hazard.

Compliance is checked by inspection and by the following test.

A 8 mm length of insulation is removed from the end of a flexible conductor having a nominal cross-sectional area as specified in Table 11. One wire of the stranded conductor is left free and the other wires are fully inserted and clamped in the terminal. The free wire is bent, without tearing the insulation back, in every possible direction but without making sharp bends around barriers.

*There shall be no contact between **live parts** and **accessible metal parts** and, for **class II constructions**, between **live parts** and metal parts separated from **accessible metal parts** by **supplementary insulation** only.*

26.6 Terminals for **type X attachment** and for the connection of cables of fixed wiring shall allow the connection of conductors having the nominal cross-sectional areas shown in Table 13. However, if a specially prepared cord is used, the terminals need only be suitable for the connection of that cord.

Table 13 – Nominal cross-sectional area of conductors

Rated current of appliance A	Nominal cross-sectional area mm ²	
	Flexible cords	Cable for fixed wiring
≤ 3	0,5 and 0,75	1 to 2,5
> 3 and ≤ 6	0,75 and 1	1 to 2,5
> 6 and ≤ 10	1 and 1,5	1 to 2,5
> 10 and ≤ 16	1,5 and 2,5	1,5 to 4
> 16 and ≤ 25	2,5 and 4	2,5 to 6
> 25 and ≤ 32	4 and 6	4 to 10
> 32 and ≤ 50	6 and 10	6 to 16
> 50 and ≤ 63	10 and 16	10 to 25

Compliance is checked by inspection, by measurement and by fitting cables or cords of the smallest and largest cross-sectional areas specified.

26.7 Terminals for **type X attachment**, other than those in **class III appliances** that do not contain **live parts**, shall be accessible after removal of a cover or part of the enclosure.

Compliance is checked by inspection.

26.8 Terminals for the connection of fixed wiring, including the earthing terminal, shall be located close to each other.

Compliance is checked by inspection.

26.9 Terminals of the pillar type shall be constructed and located so that the end of a conductor introduced into the hole is visible, or can pass beyond the threaded hole for a distance equal to half the nominal diameter of the screw but at least 2,5 mm.

Compliance is checked by inspection and by measurement.

26.10 Terminals with screw clamping and screwless terminals shall not be used for the connection of the conductors of flat twin tinsel cords unless the ends of the conductors are fitted with means suitable for use with screw terminals.

Compliance is checked by inspection and by applying a pull of 5 N to the connection.

After the test, the connection shall show no damage that could impair compliance with this standard.

26.11 For appliances having **type Y attachment** or **type Z attachment**, soldered, welded, crimped or similar connections may be used for the connection of external conductors. For **class II appliances**, the conductor shall be positioned or fixed so that reliance is not placed upon the soldering, crimping or welding alone to maintain the conductor in position. However, these methods may be used alone if barriers are provided so that **clearances and creepage distances** between **live parts** and other metal parts cannot be reduced below the values specified for **supplementary insulation**, if the conductor becomes free at the soldered or welded joint or slips out of the crimped connection.

Compliance is checked by inspection and by measurement.

27 Provision for earthing

27.1 Accessible metal parts, including metal parts behind a decorative cover that does not withstand the test of 21.1, of **class 0I appliances** and **class I appliances** that may become live in the event of a failure of **basic insulation**, shall be permanently and reliably connected to an earthing terminal within the appliance or to the earthing contact of the appliance inlet.

Earthing terminals and earthing contacts shall not be connected to the neutral terminal.

Class 0 appliances, **class II appliances** and **class III appliances** shall have no provision for protective earthing.

Safety extra-low voltage circuits shall not be earthed unless they are **protective extra-low voltage circuits**.

Compliance is checked by inspection.

27.2 The clamping means of earthing terminals shall be adequately secured against accidental loosening.

Terminals for the connection of external equipotential bonding conductors shall allow the connection of conductors having nominal cross-sectional areas of 2,5 mm² to 6 mm² and shall not be used to provide earthing continuity between different parts of the appliance. It shall not be possible to loosen the conductors without the aid of a **tool**.

NOTE The terminal for the earthing conductor in a **supply cord** is not a terminal for external equipotential bonding conductors.

Compliance is checked by inspection and by manual test.

27.3 If a **detachable part** having an earth connection is plugged into another part of the appliance, the earth connection shall be made before the current-carrying connections are established. The current-carrying connections shall be separated before the earth connection when removing the part.

For appliances with **supply cords**, the arrangement of the terminals, or the length of the conductors between the cord anchorage and the terminals, shall be such that the current-

carrying conductors become taut before the earthing conductor if the cord slips out of the cord anchorage.

Compliance is checked by inspection and by manual test.

27.4 All parts of the earthing terminal intended for the connection of external conductors shall be such that there is no risk of corrosion resulting from contact between these parts and the copper of the earthing conductor or any other metal in contact with these parts.

Parts providing earthing continuity, other than parts of a metal frame or enclosure, shall be of metal having adequate resistance to corrosion, unless they are parts of copper or copper alloys containing at least 58 % copper for parts that are processed by cold forming, and at least 50 % copper for other parts, or unless they are parts of stainless steel containing at least 13 % chrome. If these parts are of steel, they shall be provided with an electroplated coating having a thickness of at least 5 μm at essential areas such as those liable to transmit a fault current.

Parts of coated or uncoated steel that are only intended to provide or to transmit contact pressure shall be adequately protected against rusting.

NOTE 1 Examples of parts providing earthing continuity and parts that are only intended to provide or to transmit contact pressure are shown in Figure 10.

NOTE 2 Parts subjected to a treatment such as chromate conversion coating are in general not considered to be adequately protected against corrosion, but they can be used to provide or to transmit contact pressure.

If the body of the earthing terminal is a part of a frame or enclosure of aluminium or aluminium alloy, precautions shall be taken to avoid the risk of corrosion resulting from contact between copper and aluminium or its alloys.

Compliance is checked by inspection and by measurement.

In case of doubt, the thickness of the coating is measured as described in ISO 2178 or in ISO 1463.

27.5 The connection between the earthing terminal or earthing contact and earthed metal parts shall have low resistance.

If the **clearances** of **basic insulation** in a **protective extra-low voltage circuit** are based on the **rated voltage** of the appliance, this requirement does not apply to connections providing earthing continuity in the **protective extra-low voltage circuit**.

Compliance is checked by the following test.

*A current derived from a source having a no-load voltage not exceeding 12 V (AC or DC) and equal to 1,5 times **rated current** of the appliance or 25 A, whichever is higher, is passed between the earthing terminal or earthing contact and each of the **accessible metal parts** in turn. The test is carried out until steady conditions have been established.*

*The voltage drop between the earthing terminal of the appliance or the earthing contact of the appliance inlet and the **accessible metal part** is measured. The resistance calculated from the current and this voltage drop shall not exceed 0,1 Ω . The resistance of the **supply cord** is not included in the resistance calculation.*

NOTE 101 If the ground continuity between system components meets the maximum values specified in 27.5, it is considered to meet the requirements without dedicated grounding conductors.

27.6 The printed conductors of printed circuit boards shall not be used to provide earthing continuity in **hand-held appliances**. They may be used to provide earthing continuity in other

appliances if at least two tracks are used with independent soldering points and the appliance complies with 27.5 for each circuit.

Compliance is checked by inspection and by the relevant tests.

28 Screws and connections

28.1 Fixings, the failure of which may impair compliance with this standard, electrical connections and connections providing earthing continuity shall withstand the mechanical stresses occurring in normal use.

Screws used for these purposes shall not be of metal that is soft or liable to creep, such as zinc or aluminium. If they are of insulating material, they shall have a nominal diameter of at least 3 mm and they shall not be used for any electrical connections or connections providing earthing continuity.

Screws used for electrical connections or for connections providing earthing continuity shall screw into metal.

Screws shall not be of insulating material if their replacement by a metal screw could impair **supplementary insulation** or **reinforced insulation**. Screws that may be removed when replacing a **supply cord** having a **type X attachment** or when undertaking **user maintenance** shall not be of insulating material if their replacement by a metal screw could impair **basic insulation**.

Compliance is checked by inspection and by the following test.

Screws and nuts are tested if they are:

- *used for electrical connections;*
- *used for connections providing earthing continuity, unless at least two screws or nuts are used;*
- *likely to be tightened:*
 - *during **user maintenance**;*
 - *when replacing a **supply cord** having a **type X attachment**;*
 - *during installation.*

The screws or nuts are tightened and loosened without jerking:

- *10 times for screws in engagement with a thread of insulating material;*
- *5 times for nuts and other screws.*

Screws in engagement with a thread of insulating material are completely removed and reinserted each time.

When testing terminal screws and nuts, a cable or flexible cord of the largest cross-sectional area specified in Table 13 is placed in the terminal. It is repositioned before each tightening.

The test is carried out by means of a suitable screwdriver, spanner or key and by applying a torque as shown in Table 14.

Column I is applicable for metal screws without heads if the screw does not protrude from the hole when tightened.

Column II is applicable for:

- other metal screws and for nuts;
- screws of insulating material:
 - having a hexagonal head with the dimension across flats exceeding the overall thread diameter;
 - with a cylindrical head and a socket for a key, the socket having a cross-corner dimension exceeding the overall thread diameter;
 - with a head having a slot or cross-slots, the length of which exceeds 1,5 times the overall thread diameter.

Column III is applicable for other screws of insulating material.

Table 14 – Torque for testing screws and nuts

Nominal diameter of screw (outer thread diameter) mm	Torque Nm		
	I	II	III
≤ 2,8	0,2	0,4	0,4
> 2,8 and ≤ 3,0	0,25	0,5	0,5
> 3,0 and ≤ 3,2	0,3	0,6	0,5
> 3,2 and ≤ 3,6	0,4	0,8	0,6
> 3,6 and ≤ 4,1	0,7	1,2	0,6
> 4,1 and ≤ 4,7	0,8	1,8	0,9
> 4,7 and ≤ 5,3	0,8	2,0	1,0
> 5,3		2,5	1,25

No damage impairing the further use of the fixings or connections shall occur.

28.2 Electrical connections and connections providing earthing continuity shall be constructed so that contact pressure is not transmitted through non-ceramic insulating material that is liable to shrink or to distort unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage or distortion of the insulating material.

This requirement does not apply to electrical connections in circuits of appliances for which:

- 30.2.2 is applicable and that carry a current not exceeding 0,5 A;
- 30.2.3 is applicable and that carry a current not exceeding 0,2 A.

Compliance is checked by inspection.

28.3 Space-threaded (sheet metal) screws shall only be used for electrical connections if they clamp the parts together.

Thread-cutting (self-tapping) screws and thread rolling screws shall only be used for electrical connections if they generate a full form standard machine screw thread. However, thread-cutting (self-tapping) screws shall not be used if they are likely to be operated by the user or installer.

Thread-cutting, thread rolling and space-threaded screws may be used in connections providing earthing continuity provided it is not necessary to disturb the connection:

- in normal use;
- during **user maintenance**;

- when replacing a **supply cord** having a **type X attachment**; or
- during installation.

At least two screws shall be used for each connection providing earthing continuity, unless the screw forms a thread having a length of at least half the diameter of the screw.

Compliance is checked by inspection.

28.4 Screws and nuts that make a mechanical connection between different parts of the appliance shall be secured against loosening by means such as spring washers, lock washers and crown type locks as part of the screw head, if they also make electrical connections or connections providing earthing continuity. Sealing compound that softens on heating may also be used to provide security against loosening but only for screw connections not subject to torsion in normal use.

This requirement does not apply to screws in the earthing circuit if at least two screws are used for the connection or if an alternative earthing circuit is provided.

Rivets used for electrical connections or for connections providing earthing continuity shall be secured against loosening if these connections are subject to torsion in normal use. A rivet having a non-circular shank or an appropriate notch may be used to secure against loosening if these connections are subject to torsion in normal use.

NOTE This requirement does not imply that more than one rivet is necessary for providing earthing continuity.

Compliance is checked by inspection and by manual test.

29 Clearances, creepage distances and solid insulation

Appliances shall be constructed so that the **clearances**, **creepage distances** and solid insulation are adequate to withstand the electrical stresses to which the appliance is liable to be subjected.

Compliance is checked by the requirements and tests of 29.1 to 29.3 that are carried out separately.

*If coatings are used on printed circuit boards to protect the microenvironment (type 1 protection) or to provide **basic insulation** (type 2 protection), normative Annex J applies. The microenvironment is pollution degree 1 under type 1 protection. For type 2 protection, the spacing between the conductors before the protection is applied shall not be less than the values as specified in Table 1 of IEC 60664-3:2016. These values apply to **functional insulation**, **basic insulation**, **supplementary insulation** as well as **reinforced insulation**.*

NOTE The requirements and tests are based on IEC 60664-1:2007 from which further information can be obtained.

Compliance is not checked on parts relating to motor-compressors if the motor-compressor complies with IEC 60335-2-34. For motor-compressors not complying with IEC 60335-2-34, the additions and modifications specified in IEC 60335-2-34:2021, Clause 29, are applicable.

29.1 Clearances shall not be less than the values specified in Table 16, taking into account the **rated impulse voltage** for the overvoltage categories of Table 15, unless, for **basic insulation** and **functional insulation**, they comply with the impulse voltage test of Clause 14.

For appliances intended for use at altitudes exceeding 2 000 m, the **clearances** in Table 16 shall be increased according to the altitude correction factor in Table A.2 of IEC 60664-1:2007.

If the construction is such that the distances could be affected by any of the following:

- distortion;
- movement of parts;
- assembly of parts;
- wear of **basic insulation**;
- wear of **functional insulation**,

the impulse voltage test is not applicable and the **clearances** for **rated impulse voltages** of 1 500 V and above specified in Table 16 are increased by 0,5 mm.

The impulse voltage test is not applicable:

- when the microenvironment is pollution degree 3; or
- for **basic insulation** of **class 0 appliances** and **class 0I appliances**; or
- to appliances intended for use at altitudes exceeding 2 000 m.

Appliances are in overvoltage category II.

NOTE 1 Informative Annex K gives information regarding overvoltage categories.

Table 15 – Rated impulse voltage

Rated voltage ^a V	Rated impulse voltage V		
	Overvoltage category		
	I	II	III
≤ 50	330	500	800
> 50 and ≤ 150	800	1 500	2 500
> 150 and ≤ 300	1 500	2 500	4 000
NOTE The values are based on the assumption that the appliance will not generate higher overvoltages than those specified. If higher overvoltages are generated, the clearances have to be increased accordingly.			
^a For multi-phase appliances, the line to neutral or line to earth voltage is used for rated voltage .			

Table 16 – Minimum clearances

Rated impulse voltage V	Minimum clearance ^a mm
330	0,5 ^{b, c, d}
500	0,5 ^{b, c, d}
800	0,5 ^{b, c, d}
1 500	0,5 ^c
2 500	1,5
4 000	3,0
6 000	5,5
8 000	8,0
10 000	11,0
NOTE If the rated impulse voltage is not specified in the table, clearances for intermediate values of Table 16 can be determined by interpolation.	

a	The distances specified apply only to clearances in air.
b	The smaller clearances specified in IEC 60664-1:2007 have not been adopted for practical reasons, such as mass-production tolerances.
c	This value is increased to 0,8 mm for pollution degree 3.
d	For tracks of printed circuit boards, this value is reduced to 0,2 mm for pollution degree 1 and pollution degree 2.

Compliance is checked by inspection and by measurement.

Parts, such as hexagonal nuts that can be tightened to different positions during assembly, and movable parts are placed in the most unfavourable position.

*A force is applied to bare conductors, other than those of heating elements, and **accessible surfaces** to try to reduce **clearances** when making the measurement. The force is:*

- 2 N, for bare conductors;
- 30 N, for **accessible surfaces**.

The force is applied by means of test probe B of IEC 61032. Apertures are assumed to be covered by a piece of flat metal.

NOTE 2 The way in which **clearances** are measured is specified in IEC 60664-1:2007.

NOTE 3 The procedure for assessing **clearances** is given in informative Annex L.

29.1.1 The **clearances** of **basic insulation** shall be sufficient to withstand the overvoltages likely to occur during use, taking into account the **rated impulse voltage**. The values of Table 16, or the impulse voltage test of Clause 14, are applicable.

The **clearance** at the terminals of tubular sheathed heating elements may be reduced to 1,0 mm if the microenvironment is pollution degree 1.

Lacquered conductors of windings are considered to be bare conductors.

Compliance is checked by measurement.

29.1.2 **Clearances** of **supplementary insulation** shall be not less than those specified in Table 16.

Compliance is checked by measurement.

29.1.3 **Clearances** of **reinforced insulation** shall be not less than those specified in Table 16, using the next higher step for **rated impulse voltage** as a reference.

*Compliance is checked by measurement. For **double insulation**, when there is no intermediate conductive part between the **basic insulation** and **supplementary insulation**, **clearances** are measured between **live parts** and the **accessible surface**, and the insulation system is treated as **reinforced insulation** as shown in Figure 11.*

29.1.4 The **clearances** for **functional insulation** are the largest values determined from:

- Table 16 based on the **rated impulse voltage**;
- Table F.7a in IEC 60664-1:2007 based on the steady-state voltage or recurring peak voltage expected to occur across it, if the frequency of the steady-state voltage or recurring peak voltage does not exceed 30 kHz;

- Clause 4 of IEC 60664-4:2005 based on the steady-state voltage or recurring peak voltage expected to occur across it, if the frequency of the steady-state voltage or recurring peak voltage exceeds 30 kHz.

If the values of Table 16 are largest, the impulse voltage test of Clause 14 may be applied instead unless the microenvironment is pollution degree 3 or the construction is such that the distances could be affected by wear, by distortion, by movement of the parts or during assembly.

However, **clearances** are not specified if the appliance complies with Clause 19 with the **functional insulation** short-circuited.

Lacquered conductors of windings are considered to be bare conductors. However, **clearances** at crossover points are not measured.

The **clearance** between surfaces of **PTC heating elements** may be reduced to 1 mm.

Compliance is checked by measurement and by a test if necessary.

29.1.5 For appliances having higher **working voltages** than **rated voltage**, for example on the secondary side of a step-up transformer, or if there is a resonant voltage, the **clearances** for **basic insulation** are the largest values determined from:

- Table 16 based on the **rated impulse voltage**;
- Table F.7a in IEC 60664-1:2007 based on the steady-state voltage or recurring peak voltage expected to occur across it, if the frequency of the steady-state voltage or recurring peak voltage does not exceed 30 kHz;
- Clause 4 of IEC 60664-4:2005 based on the steady-state voltage or recurring peak voltage expected to occur across it, if the frequency of the steady-state voltage or recurring peak voltage exceeds 30 kHz.

If the **clearances** applied for **basic insulation** are selected from Table F.7a of IEC 60664-1:2007 or Clause 4 of IEC 60664-4:2005, then the **clearances** of **supplementary insulation** shall be not less than those specified for **basic insulation**.

If the **clearances** applied for **basic insulation** are selected from Table F.7a of IEC 60664-1:2007, then the **clearances** of **reinforced insulation** shall be dimensioned as specified in Table F.7a to withstand 160 % of the withstand voltage required for **basic insulation**.

If the **clearances** applied for **basic insulation** are selected from Clause 4 of IEC 60664-4:2005, then the **clearances** of **reinforced insulation** shall be twice the value required for **basic insulation**.

If the secondary winding of a step-down transformer is earthed, or if there is an earthed screen between the primary and secondary windings, **clearances** of **basic insulation** on the secondary side shall be not less than those specified in Table 16, using the next lower step for **rated impulse voltage** as a reference.

For circuits supplied with a voltage lower than **rated voltage**, for example on the secondary side of a transformer, **clearances** of **functional insulation** are based on the **working voltage**, which is used as the **rated voltage** in Table 15.

Compliance is checked by measurement.

29.2 Appliances shall be constructed so that **creepage distances** are not less than those appropriate for the **working voltage**, taking into account the material group and the pollution degree.

NOTE 1 The **working voltage** for parts connected to the neutral is the same as for parts connected to the line and this is the **working voltage** for **basic insulation**.

Pollution degree 2 applies unless:

- precautions have been taken to protect the insulation, in which case pollution degree 1 applies;
- the insulation is subjected to conductive pollution, in which case pollution degree 3 applies.

NOTE 2 An explanation of pollution degree is given in informative Annex M.

For insulation located in any airflow, the micro-environment is pollution degree 3 unless the insulation is enclosed or located so that it is unlikely to be exposed to pollution due to normal use of the appliance.

Compliance is checked by measurement.

NOTE 3 The way in which **creepage distances** are measured is specified in IEC 60664-1:2007.

Parts such as hexagonal nuts that can be tightened to different positions during assembly, and movable parts are placed in the most unfavourable position.

*A force is applied to bare conductors, other than those of heating elements, and **accessible surfaces** to try to reduce **creepage distances** when making the measurement. The force is:*

- 2 N, for bare conductors;
- 30 N, for **accessible surfaces**.

The force is applied by means of test probe B of IEC 61032.

The relationship between the material group and the comparative tracking index (CTI) values, as given in Subclause 4.8.1.3 of IEC 60664-1:2007, is as follows:

- material group I: $600 \leq CTI$;
- material group II: $400 \leq CTI < 600$;
- material group IIIa: $175 \leq CTI < 400$;
- material group IIIb: $100 \leq CTI < 175$.

These CTI values are obtained in accordance with IEC 60112:2003 including IEC 60112:2003/AMD1:2009 using solution A. If the CTI value of the material is unknown, a proof tracking index (PTI) test in accordance with normative Annex N is carried out at the CTI values specified, in order to establish the material group.

NOTE 4 The procedure for assessing **creepage distances** is given in informative Annex L.

*In a **double insulation** system, the **working voltage** for both the **basic insulation** and **supplementary insulation** is taken as the **working voltage** across the complete **double insulation** system. It is not divided according to thickness and dielectric constants of the **basic insulation** and **supplementary insulation**.*

29.2.1 Creepage distances of basic insulation shall not be less than those specified in Table 17. However, if the **working voltage** is periodic and has a frequency that exceeds 30 kHz,

the **creepage distances** shall also be determined from Table 2 of IEC 60664-4:2005. These values shall be used instead if they exceed the values in Table 17.

Except for pollution degree 1, if the test of Clause 14 has been used to check a particular **clearance**, the corresponding **creepage distance** shall not be less than the minimum dimension specified for the **clearance** of Table 16.

Table 17 – Minimum creepage distances for basic insulation

Working voltage V	Creepage distance mm						
	Pollution degree						
	1	2			3		
		Material group			Material group		
		I	II	IIIa/IIIb	I	II	IIIa/IIIb ^a
≤ 50	0,18	0,6	0,85	1,2	1,5	1,7	1,9
125	0,28	0,75	1,05	1,5	1,9	2,1	2,4
250	0,56	1,25	1,8	2,5	3,2	3,6	4,0
400	1,0	2,0	2,8	4,0	5,0	5,6	6,3
500	1,3	2,5	3,6	5,0	6,3	7,1	8,0
> 630 and ≤ 800	1,8	3,2	4,5	6,3	8,0	9,0	10,0
> 800 and ≤ 1 000	2,4	4,0	5,6	8,0	10,0	11,0	12,5
> 1 000 and ≤ 1 250	3,2	5,0	7,1	10,0	12,5	14,0	16,0
> 1 250 and ≤ 1 600	4,2	6,3	9,0	12,5	16,0	18,0	20,0
> 1 600 and ≤ 2 000	5,6	8,0	11,0	16,0	20,0	22,0	25,0
> 2 000 and ≤ 2 500	7,5	10,0	14,0	20,0	25,0	28,0	32,0
> 2 500 and ≤ 3 200	10,0	12,5	18,0	25,0	32,0	36,0	40,0
> 3 200 and ≤ 4 000	12,5	16,0	22,0	32,0	40,0	45,0	50,0
> 4 000 and ≤ 5 000	16,0	20,0	28,0	40,0	50,0	56,0	63,0
> 5 000 and ≤ 6 300	20,0	25,0	36,0	50,0	63,0	71,0	80,0
> 6 300 and ≤ 8 000	25,0	32,0	45,0	63,0	80,0	90,0	100,0
> 8 000 and ≤ 10 000	32,0	40,0	56,0	80,0	100,0	110,0	125,0
> 10 000 and ≤ 12 500	40,0	50,0	71,0	100,0	125,0	140,0	160,0

NOTE 1 Lacquered conductors of windings are considered to be bare conductors, but **creepage distances** for **basic insulation** in other than a **double insulation** construction need not be greater than the associated **clearance** specified in Table 16 taking into account 29.1.1.

NOTE 2 For glass, ceramics and other inorganic insulating materials that do not track, **creepage distances** need not be greater than the associated **clearance**.

NOTE 3 Except for circuits on the secondary side of an isolating transformer, the **working voltage** is considered to be not less than the **rated voltage** of the appliance.

NOTE 4 For **working voltages** > 50 V and ≤ 630 V, if the voltage is not specified in the table, the values of **creepage distances** can be found by interpolation.

^a Material group IIIb is allowed if the **working voltage** does not exceed 50 V.

Compliance is checked by measurement.

29.2.2 Creepage distances of supplementary insulation shall be at least those specified for **basic insulation** in Table 17, excluding its NOTE 1 and NOTE 2, or Table 2 of IEC 60664-4:2005, as applicable.

Compliance is checked by measurement.

29.2.3 Creepage distances of reinforced insulation shall be at least double those specified for **basic insulation** in Table 17, excluding its NOTE 1 and NOTE 2, or Table 2 of IEC 60664-4:2005, as applicable.

Compliance is checked by measurement.

29.2.4 Creepage distances of functional insulation shall be not less than those specified in Table 18. However, if the **working voltage** is periodic and has a frequency that exceeds 30 kHz, the **creepage distances** shall also be determined from Table 2 of IEC 60664-4:2005. These values shall be used instead if they exceed the values in Table 18.

The **creepage distances** may be reduced if the appliance complies with Clause 19 with the **functional insulation** short-circuited.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Table 18 – Minimum creepage distances for functional insulation

Working voltage V	Creepage distance mm						
	Pollution degree ^a						
	1	2			3		
		Material group			Material group		
		I	II	IIIa/IIIb	I	II	IIIa/IIIb ^b
≤ 10	0,08	0,4	0,4	0,4	1,0	1,0	1,0
50	0,16	0,56	0,8	1,1	1,4	1,6	1,8
125	0,25	0,71	1,0	1,4	1,8	2,0	2,2
250	0,42	1,0	1,4	2,0	2,5	2,8	3,2
400 ^c	0,75	1,6	2,2	3,2	4,0	4,5	5,0
500	1,0	2,0	2,8	4,0	5,0	5,6	6,3
> 630 and ≤ 800	1,8	3,2	4,5	6,3	8,0	9,0	10,0
> 800 and ≤ 1 000	2,4	4,0	5,6	8,0	10,0	11,0	12,5
> 1 000 and ≤ 1 250	3,2	5,0	7,1	10,0	12,5	14,0	16,0
> 1 250 and ≤ 1 600	4,2	6,3	9,0	12,5	16,0	18,0	20,0
> 1 600 and ≤ 2 000	5,6	8,0	11,0	16,0	20,0	22,0	25,0
> 2 000 and ≤ 2 500	7,5	10,0	14,0	20,0	25,0	28,0	32,0
> 2 500 and ≤ 3 200	10,0	12,5	18,0	25,0	32,0	36,0	40,0
> 3 200 and ≤ 4 000	12,5	16,0	22,0	32,0	40,0	45,0	50,0
> 4 000 and ≤ 5 000	16,0	20,0	28,0	40,0	50,0	56,0	63,0
> 5 000 and ≤ 6 300	20,0	25,0	36,0	50,0	63,0	71,0	80,0
> 6 300 and ≤ 8 000	25,0	32,0	45,0	63,0	80,0	90,0	100,0
> 8 000 and ≤ 10 000	32,0	40,0	56,0	80,0	100,0	110,0	125,0
> 10 000 and ≤ 12 500	40,0	50,0	71,0	100,0	125,0	140,0	160,0

NOTE 1 For **PTC heating elements**, the **creepage distances** over the surface of the PTC material need not be greater than the associated **clearance** for **working voltages** less than 250 V and for pollution degrees 1 and 2. However, the **creepage distances** between terminations are those specified in the table.

NOTE 2 For glass, ceramics and other inorganic insulating materials that do not track, **creepage distances** need not be greater than the associated **clearance**.

NOTE 3 For **working voltages** > 10 V and ≤ 630 V, if the voltage is not specified in the table, the values of **creepage distances** can be found by interpolation.

^a For tracks on printed wiring boards under pollution degree 1 and pollution degree 2 conditions, the values specified in Table F.4 of IEC 60664-1:2007 apply. For voltages less than 100 V, the values shall not be less than those specified for 100 V.

^b Material group IIIb is allowed if the **working voltage** does not exceed 50 V.

^c The **working voltage** between phases for appliances having a **rated voltage** in the range of 380 V to 415 V is considered to be 400 V.

Compliance is checked by measurement.

29.3 Supplementary insulation and reinforced insulation shall have adequate thickness, or have a sufficient number of layers, to withstand the electrical stresses that can be expected during the use of the appliance.

Compliance is checked:

- by measurement, in accordance with 29.3.1, or
- by an electric strength test in accordance with 29.3.2, if the insulation consists of more than one separate layer, other than natural mica or similar flaky material, or
- for insulation, other than single layer internal wiring insulation, by an assessment of the thermal quality of the material combined with an electric strength test, in accordance with 29.3.3 and for **accessible parts of reinforced insulation** consisting of a single layer, by measurement in accordance with 29.3.4, or
- by an assessment of the thermal quality of the material according to 29.3.3 combined with an electric strength test in accordance with 23.5, for each single layer internal wiring insulation touching each other, or
- as specified in Subclause 6.3 of IEC 60664-4:2005 for insulation that is subjected to any periodic voltage having a frequency that exceeds 30 kHz.

29.3.1 The thickness of the insulation shall be at least:

- 1 mm for **supplementary insulation**;
- 2 mm for **reinforced insulation**.

29.3.2 Each layer of material shall withstand the electric strength test of 16.3 for **supplementary insulation**. **Supplementary insulation** shall consist of at least 2 layers of material and **reinforced insulation** of at least 3 layers.

29.3.3 The insulation is subjected to the dry heat test Bb of IEC 60068-2-2 for 48 h at a temperature of 50 K in excess of the maximum temperature rise measured during the test of Clause 19. At the end of the period, the insulation is subjected to the electric strength test of 16.3 at the conditioning temperature and also after it has cooled down to **room temperature**.

If the temperature rise of the insulation measured during the tests of Clause 19 does not exceed the value specified in Table 3, the test of IEC 60068-2-2 is not carried out.

29.3.4 The thickness of the **accessible parts of reinforced insulation** consisting of a single layer shall not be less than those specified in Table 19.

Table 19 – Minimum thickness for accessible parts of reinforced insulation consisting of a single layer

Rated voltage V	Minimum thickness of single layers used for accessible parts of reinforced insulation mm		
	Overvoltage category		
	I	II	III
≤ 50	0,01	0,04	0,1
> 50 and ≤ 150	0,1	0,3	0,6
> 150 and ≤ 300	0,3	0,6	1,2

NOTE The values in Table 19 cover **clearances** through a possible hole in the insulation and align with IEC 60664-1:2007 Table F.2 for homogenous field conditions. The **creepage distance** through a possible hole is not considered relevant because it is only stressed when the second electrode (human body) is present.

30 Resistance to heat and fire

30.1 External parts of non-metallic material, parts of insulating material supporting **live parts** including connections, and parts of thermoplastic material providing **supplementary insulation** or **reinforced insulation** shall be sufficiently resistant to heat if their deterioration could cause the appliance to fail to comply with this standard.

This requirement does not apply to:

- the insulation or sheath of flexible cords or internal wiring;
- those parts of coil formers that do not support or retain terminals in position;
- parts of ceramic material.

*Compliance is checked by subjecting the relevant part to the ball pressure test of IEC 60695-10-2. However, for external parts of **particle foam material** made of*

- expanded polypropylene (EPP), or
- expanded polystyrene (EPS)

*which are not supporting **live parts** and are at least 8 mm thick and have a density equal to or more than 55 kg/m³ and less than or equal to 250 kg/m³ compliance is checked by the test of 30.101.*

NOTE 101 Measurement of density can be made according to ISO 845.

The test is carried out at a temperature of 40 °C ± 2 °C plus the maximum temperature rise determined during the test of Clause 11, but it shall be at least:

- 75 °C ± 2 °C, for external parts;
- 125 °C ± 2 °C, for parts supporting **live parts**.

*However, for parts of thermoplastic material providing **supplementary insulation** or **reinforced insulation**, the test is carried out at a temperature of 25 °C ± 2 °C plus the maximum temperature rise determined during the tests of Clause 19, if this is higher. The temperature rises obtained during the tests of 19.4 and 19.5 are not taken into account provided that the test is terminated by the operation of a **non-self-resetting protective device** and it is necessary to remove a cover or use a **tool** to reset it.*

NOTE The selection and sequence of tests for resistance to heat are shown in Figure O.1 of informative Annex O.

30.2 Parts of non-metallic material shall be resistant to ignition and spread of fire.

The requirement does not apply to parts having a mass not exceeding 0,5 g which are considered insignificant parts, provided the cumulative effect of insignificant parts located within 3 mm of each other is unlikely to propagate flames that originate inside the appliance by propagating flames from one insignificant part to another.

The requirement also does not apply to decorative trims, knobs and other parts unlikely to be ignited or to propagate flames that originate inside the appliance.

Compliance is checked by the test of 30.2.1. In addition:

- for attended appliances, 30.2.2 is applicable;
- for unattended appliances, 30.2.3 is applicable.

*Appliances for **remote operation** are considered to be appliances that are operated while unattended and consequently they are subjected to the test of 30.2.3.*

For parts of the appliance that are connected to the supply mains during the charging period, 30.2.3 applies.

For the base material of printed circuit boards, compliance is checked by the test of 30.2.4.

The tests are carried out on parts of non-metallic material that have been removed from the appliance. When the glow-wire test is carried out, the parts are placed in the same orientation as they would be in normal use.

NOTE 1 For parts that have been removed, it is the intention that IEC 60695-2-11:2014, 4.3.c) applies, which states "remove the part under examination in its entirety and test it separately".

These tests are not carried out on the insulation of wires.

NOTE 2 The selection and sequence of tests for resistance to fire are shown in Figure O.2 to Figure O.4 of informative Annex O.

30.2.1 *Parts of non-metallic material are subjected to the glow-wire test of IEC 60695-2-11:2014, which is carried out at 550 °C. However, the glow-wire test is not carried out on parts of material classified as having a glow-wire flammability index (GWFI) according to IEC 60695-2-12 of at least 550 °C.*

If the glow-wire flammability index (GWFI) is not available for a sample with a thickness within $\pm 0,1$ mm of the relevant part, then the test sample shall have a thickness equal to the nearest preferred value specified in IEC 60695-2-12 that is no thicker than the relevant part.

The glow-wire test is also not carried out on parts of material classified at least HB40 according to IEC 60695-11-10 provided that the test sample used for the classification was no thicker than the relevant part of the appliance.

Parts for which the glow-wire test cannot be carried out, such as those made of soft or foamy material, shall meet the requirements specified in ISO 9772 for material classified HBF, the test sample used for the classification being no thicker than the relevant part of the appliance.

30.2.2 Not applicable.

30.2.3 *Appliances that are operated while unattended are tested as specified in 30.2.3.1 and 30.2.3.2. However, the tests are not applicable to:*

- *parts supporting welded connections and parts within a distance of 3 mm of these connections;*
- *parts supporting connections in low-power circuits described in 19.11.1 and parts within a distance of 3 mm of these connections;*
- *soldered connections on printed circuit boards and parts within a distance of 3 mm of these connections;*
- *connections on small components on printed circuit boards, such as diodes, transistors, resistors, inductors, integrated circuits and capacitors not directly connected to the supply mains, and parts within a distance of 3 mm of these connections.*

NOTE Some applications of the term "within a distance of 3 mm" are shown in Figure O.5 of informative Annex O.

30.2.3.1 *Parts of non-metallic material supporting connections, such as switch contacts and similar contacts in other components, that carry a current exceeding 0,2 A during **normal operation**, and parts of non-metallic material, other than **small parts**, within a distance of 3 mm of such connections, are subjected to the glow-wire test of IEC 60695-2-11:2014 with a test severity of 850 °C.*

The tip of the glow-wire should be applied to the part in the vicinity of the connection.

Where a non-metallic material is within a distance of 3 mm of a current-carrying connection, but is shielded from the connection by a different material, the glow-wire test of IEC 60695-2-11:2014 is carried out at the relevant temperature with the tip of the glow-wire applied to the interposed shielding material with the shielded material in place and not directly to the shielded material.

However, the glow-wire test of IEC 60695-2-11:2014 with a test severity of 850 °C is not carried out on parts of material classified as having a glow-wire flammability index (GWFI) of at least 850 °C according to IEC 60695-2-12.

If the glow-wire flammability index (GWFI) is not available for a sample with a thickness within $\pm 0,1$ mm of the relevant part, then the test sample shall have a thickness equal to the nearest preferred value specified in IEC 60695-2-12 that is no thicker than the relevant part.

30.2.3.2 Parts of non-metallic material supporting connections, such as switch contacts and similar contacts in other components and parts of non-metallic material within a distance of 3 mm of such connections are subjected to the glow-wire test of IEC 60695-2-11:2014.

The tip of the glow-wire should be applied to the part in the vicinity of the connection.

The test severity is:

- 750 °C, for connections that carry a current exceeding 0,2 A during **normal operation**;
- 650 °C, for other connections.

Where a non-metallic material is within a distance of 3 mm of a current-carrying connection, but is shielded from the connection by a different material, the glow-wire test of IEC 60695-2-11:2014 is carried out at the relevant test severity with the tip of the glow-wire applied to the interposed shielding material with the shielded material in place and not directly to the shielded material.

However, the glow-wire test with a test severity of 750 °C or 650 °C as appropriate, is not carried out on parts of material fulfilling both or either of the following classifications:

- a glow-wire ignition temperature (GWIT) according to IEC 60695-2-13 of at least;
 - 775 °C, for connections that carry a current exceeding 0,2 A during **normal operation**;
 - 675 °C, for other connections.
- a glow-wire flammability index (GWFI) according to IEC 60695-2-12 of at least;
 - 750 °C, for connections that carry a current exceeding 0,2 A during **normal operation**;
 - 650 °C, for other connections.

If the glow-wire ignition temperature (GWIT) is not available for a sample with a thickness within $\pm 0,1$ mm of the relevant part, then the test sample shall have a thickness equal to the nearest preferred value specified in IEC 60695-2-13 that is no thicker than the relevant part.

If the glow-wire flammability index (GWFI) is not available for a sample with a thickness within $\pm 0,1$ mm of the relevant part, then the test sample shall have a thickness equal to the nearest preferred value specified in IEC 60695-2-12 that is no thicker than the relevant part.

The glow-wire test of IEC 60695-2-11:2014 with a test severity of 750 °C or 650 °C as appropriate, is also not carried out on **small parts**. These parts shall:

- comprise material having a glow-wire ignition temperature (GWIT) of at least 775 °C or 675 °C as appropriate; or
- comprise material having a glow-wire flammability index (GWFI) of at least 750 °C or 650 °C as appropriate; or

- comply with the needle-flame test (NFT) of normative Annex E; or
- comprise material classified as V-0 or V-1 according to IEC 60695-11-10 provided that the test sample used for the classification was no thicker than the relevant part of the appliance.

A consequential needle-flame test (NFT) in accordance with normative Annex E is applied to non-metallic parts that encroach within the envelope of a vertical cylinder having a diameter of 20 mm and a height of 50 mm, placed above the centre of the connection zone and on top of the non-metallic parts that are supporting current-carrying connections, and parts of non-metallic material within a distance of 3 mm of such connections if these parts are those:

- that withstood the glow-wire test of IEC 60695-2-11:2014 with a test severity of 750 °C or 650 °C as appropriate, but that during the test produce a flame that persists for longer than 2 s; or
- that comprised material having a glow-wire flammability index (GWFI) of at least 750 °C, or 650 °C as appropriate; or
- **small parts**, that comprised material having a glow-wire flammability index (GWFI) of at least 750 °C, or 650 °C as appropriate; or
- **small parts** for which the needle-flame test (NFT) of normative Annex E was applied; or
- **small parts** for which a material classification of V-0 or V-1 was applied.

NOTE An example of the placement of the vertical cylinder is shown in Figure 12.

However, the consequential needle-flame test is not carried out on non-metallic parts, including **small parts**, within the cylinder that are parts:

- having a glow-wire ignition temperature (GWIT) of at least 775 °C, or 675 °C as appropriate; or
- comprising material classified as V-0 or V-1 according to IEC 60695-11-10 provided that the test sample used for the classification was no thicker than the relevant part of the appliance; or
- shielded by a flame barrier that meets the needle-flame test (NFT) of normative Annex E or that comprises material classified as V-0 or V-1 according to IEC 60695-11-10 provided that the test sample used for the classification was no thicker than the relevant part of the appliance.

There shall be no **battery** in the area of the vertical cylinder used for the consequential needle flame test, unless the **battery** is shielded by a barrier that meets the needle flame test of normative Annex E or that comprises material classified as V-0 or V-1 according to IEC 60695-11-10, provided that the test sample used for the classification was no thicker than the relevant part of the appliance.

30.2.4 The base material of printed circuit boards is subjected to the needle-flame test (NFT) of normative Annex E. The flame is applied to the edge of the board where the heat sink effect is lowest when the board is positioned as in normal use.

NOTE The test can be carried out on a printed circuit board on which components are mounted. However, ignition of a component is disregarded.

The needle-flame test (NFT) of normative Annex E is not carried out on:

- printed circuit boards of low-power circuits described in 19.11.1;
- the printed circuit boards in:
 - a metal enclosure that confines flames or burning droplets;
 - **hand-held appliances**;
 - appliances that have to be kept switched on by hand or foot;
 - appliances that are continuously loaded by hand.

- a base material classified as V-0 according to IEC 60695-11-10 or VTM-0 according to ISO 9773, provided that the test sample used for the classification was no thicker than the printed circuit board.

30.101 The ball pressure test for **particle foam material** is carried out using the apparatus specified in IEC 60695-10-2:2014, Clause 5, using the loading device shown in Figure 1a with additional dimensions and shape as shown in Figure 105.

The size of test specimen shall be at least 60 mm × 60 mm.

The weight shall be applied to the outer surface of the part, and not to a cut-away exposing an interior substrate for the purposes of sample preparation.

The test specimen shall be stored for at least 24 h before the test in an atmosphere having a temperature between 15 °C and 35 °C and a relative humidity between 45 % and 75 %.

Place the test specimen in the approximate centre of the test specimen support ensuring that its upper surface is horizontal. Gently lower the pressure ball of the loading device on to the approximate centre of the test specimen. Ensure that no conditions exist that will cause the pressure ball to move other than in a downward direction during the test.

The installation of the test specimen and application of the weight shall be performed within 30 s. The test chamber shall return to the specified temperature (± 2 °C) within 5 min and without any overshoot exceeding 5 °C.

The test specimen with the loading device shall remain for a period of 60^{+2}_0 min in the test chamber.

The thickness of the sample at the point of contact with the loading device shall be measured before and immediately after the conditioning in the chamber according to Figure 106.

The test shall be performed at a temperature (40 ± 2) K above the maximum temperature rise measured at accessible surface during the test in Clause 11, but not less than 75 °C.

NOTE There can be a big difference between the internal and external surface of thermal isolation.

However, for parts providing **supplementary insulation** or **reinforced insulation**, the test shall be performed at a temperature, which is (25 ± 2) K above the maximum temperature rise measured during the test in Clause 19, if this is higher. The temperature rises of Clause 19 are not considered, provided the tests of Clause 19 are terminated by a **non-self-resetting protective device**. The resetting of the **non-self-resetting protective device** shall require removal of a cover or the using of a **tool**.

After the test, the thickness of the material shall be no less than 50 % of the original material thickness but not less than 4 mm.

31 Resistance to rusting

Ferrous parts, the rusting of which might cause the appliance to fail to comply with this standard, shall be adequately protected against rusting.

Unless otherwise specified in the relevant part 2, the appliance is deemed to comply with the requirement without testing.

Compliance is checked by the salt mist test of IEC 60068-2-52, severity 2 being applicable.

Before the test, coatings are scratched by means of a hardened steel pin, the end of which has the form of a cone with an angle of 40°. Its tip is rounded with a radius of 0,25 mm ± 0,02 mm. The pin is loaded so that the force exerted along its axis is 10 N ± 0,5 N. The scratches are made by drawing the pin along the surface of the coating at a speed of approximately 20 mm/s. Five scratches are made at least 5 mm apart and at least 5 mm from the edges.

After the test, the appliance shall not have deteriorated to such an extent that compliance with this standard is impaired. The coating shall not be broken and shall not have loosened from the metal surface.

NOTE 101 This test can in particular affect compliance with Clause 8 and Clause 27.

32 Radiation, toxicity and similar hazards

32.1 Appliances shall not emit harmful radiation or present a toxic or similar hazard due to their operation in normal use.

Unless otherwise specified in the relevant part 2, the appliance is deemed to comply with the requirement without testing.

32.2 Appliances shall not present an optical radiation hazard due to their operation in normal use.

This requirement does not apply to lamps and lamp systems that comply with 24.1.10.

*Compliance is checked as follows with the appliance supplied at **rated voltage**.*

Radiation assessment is performed at or recalculated to 200 mm distance or at the fixed use distance indicated in the instructions for use, following the measurement procedure described in IEC 62471:2006.

If a lamp or lamp system is intended to illuminate objects, it shall be assessed at the GLS assessment distance which produces a luminance of 500 lux as described in IEC 62471:2006.

The appliance shall comply with the exempt group classification requirements of IEC 62471:2006 regarding actinic ultraviolet hazard (E_S) and near-UV hazard (E_{UVA}).

NOTE To avoid errors associated with low signal to noise ratio from spectroradiometers, handheld radiometers with specialized detectors sensitive to either the actinic UV or UV-A region can be used for these measurements.

32.101 For UV-C irradiance test:

32.101.1 For the occupied space outside the unit, a test shall be performed to determine the **UV-C spectral irradiance**. The emissions from the equipment shall not exceed a **UV-C spectral irradiance** limit of 0,2 $\mu\text{W}/\text{cm}^2$.

NOTE The **UV-C spectral irradiance** limit of 0,2 $\mu\text{W}/\text{cm}^2$ is equivalent to 0,1 $\mu\text{W}/\text{cm}^2$ effective irradiance at 254 nm (i.e., 0,2 $\mu\text{W}/\text{cm}^2$ multiplied by the hazard function, $S_{UV} = 0,5$ at 254 nm as defined in IEC 62471 equals 0,1 $\mu\text{W}/\text{cm}^2$). Effective irradiance of 0,1 $\mu\text{W}/\text{cm}^2$ is classified as exempt in IEC 62471.

32.101.2 For areas inside the unit that are accessible for anticipated **user maintenance** and are not equipped with the interlock required by 22.128, there shall be no **UV-C spectral irradiance** greater than 1,7 $\mu\text{W}/\text{cm}^2$. The **UV-C spectral irradiance** is measured at any point of accessibility required for **user maintenance**. When determining user accessibility, consideration should be given to the maximum exposure time of 60 min/day at 1,7 $\mu\text{W}/\text{cm}^2$ **spectral irradiance**, that the user would experience in performing their duties.

NOTE The **UV-C spectral irradiance** limit of $1,7 \mu\text{W}/\text{cm}^2$ is equivalent to $0,85 \mu\text{W}/\text{cm}^2$ effective irradiance at 254 nm (i.e., $1,7 \mu\text{W}/\text{cm}^2$ multiplied by the hazard function, $S_{\text{UV}} = 0,5$ at 254 nm as defined in IEC 62471 equals $0,85 \mu\text{W}/\text{cm}^2$).

Compliance is determined by measuring the **UV-C spectral irradiance** in accordance with IEC 62471:2006, Clause 5 and Annex B.

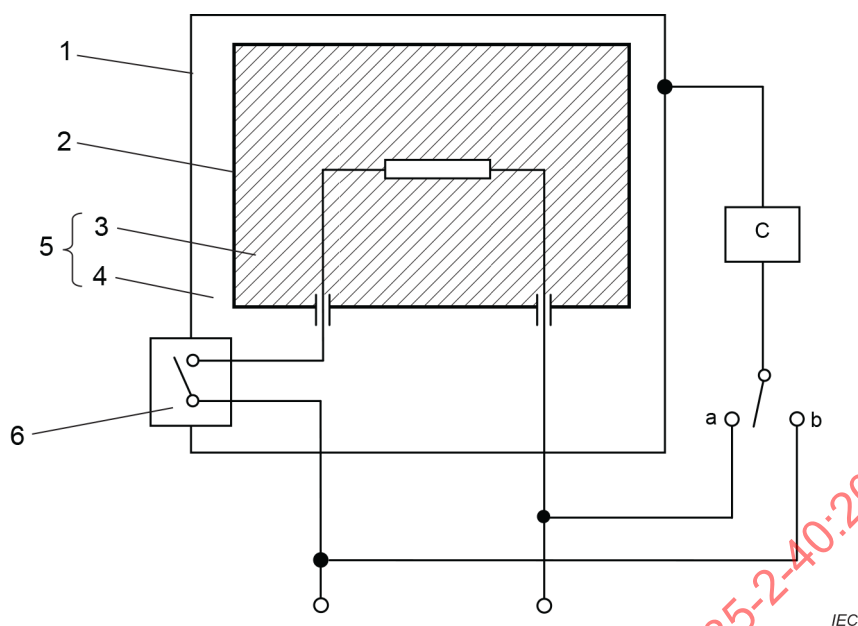
32.101.3 UV-C spectral irradiance shall be measured at the location indicated in Table 102.

Table 102 – UV-C spectral irradiance measurement location

	UV-C spectral irradiance limits		For compliance, UV-C spectral irradiance is measured
	$\mu\text{W}/\text{cm}^2$	W/m^2	
Occupied space outside unit	$\leq 0,2^a$	$\leq 0,002$	At 0,3 m from all outside surfaces of appliance ^c
Supply and return air openings	$\leq 0,2^a$	$\leq 0,002$	At 0,3 m from the perpendicular plane of the opening
User maintenance openings ^b	$\leq 1,7$	$\leq 0,017$	At 0,3 m from the perpendicular plane of the access opening
UV-C lamp replacement			Not required – all power shall be disconnected
^a Less than or equal to $0,1 \mu\text{W}/\text{cm}^2$ effective irradiance is exempt according to IEC 62471. This is $0,2 \mu\text{W}/\text{cm}^2$ spectral irradiance at 254 nm. ^b Based on maximum exposure time of 60 min/day. ^c If the appliance has an inspection window, the measuring distance is reduced to 0,0 m.			

32.101.4 When conducting **UV-C spectral irradiance** tests

- the **UV-C spectral irradiance** measurements shall be conducted with a scanning spectroradiometer, or a narrow band range radiometer;
- all panels and components shall be positioned or adjusted in the most severe position;
- removable air filters shall be removed;
- measurements shall be made at the worst case location and angle of incidence;
- the minimum specified duct and configuration, including any duct liners, specified by the manufacturer shall be in place and the measurements taken at the opening at the end of the duct.



Key

C circuit of Figure 4 of IEC 60990:2016

1 **accessible part**

2 **inaccessible metal part**

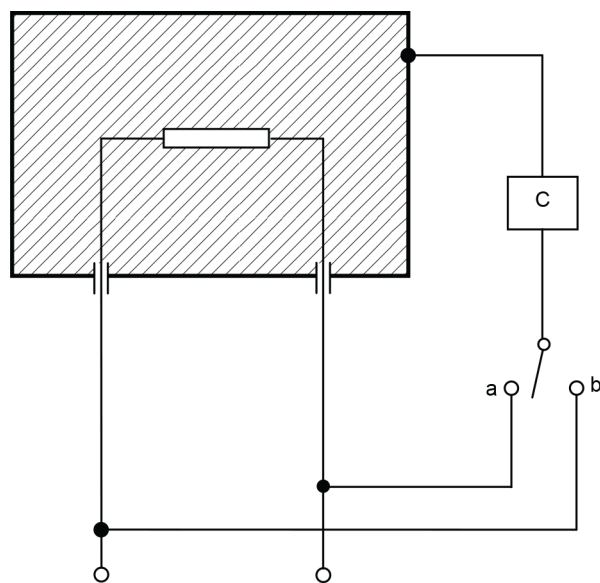
3 **basic insulation**

4 **supplementary insulation**

5 **double insulation**

6 **reinforced insulation**

Figure 1 – Circuit diagram for leakage current measurement at operating temperature for single-phase connection of class II appliances and for parts of class II construction

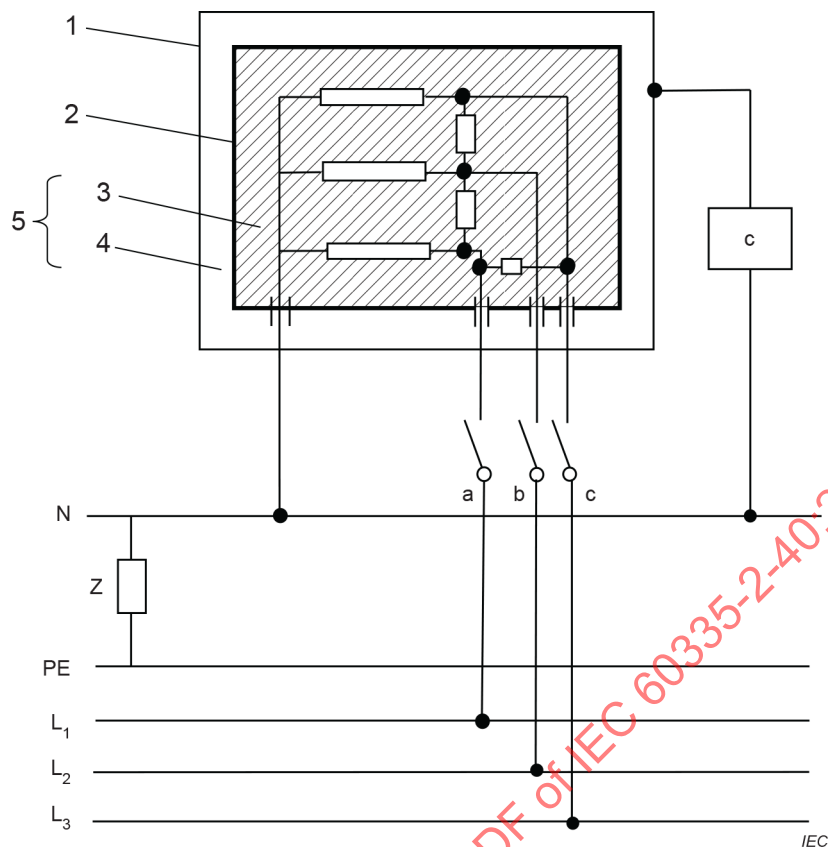


Key

C circuit of Figure 4 of IEC 60990:2016

NOTE For **class 01 appliances** and **class I appliances**, C can be replaced by a low impedance ammeter responding to the **rated frequency** of the appliance.

Figure 2 – Circuit diagram for leakage current measurement at operating temperature for single-phase connection of other than class II appliances or parts of class II construction

**Key**

C circuit of Figure 4 of IEC 60990:2016

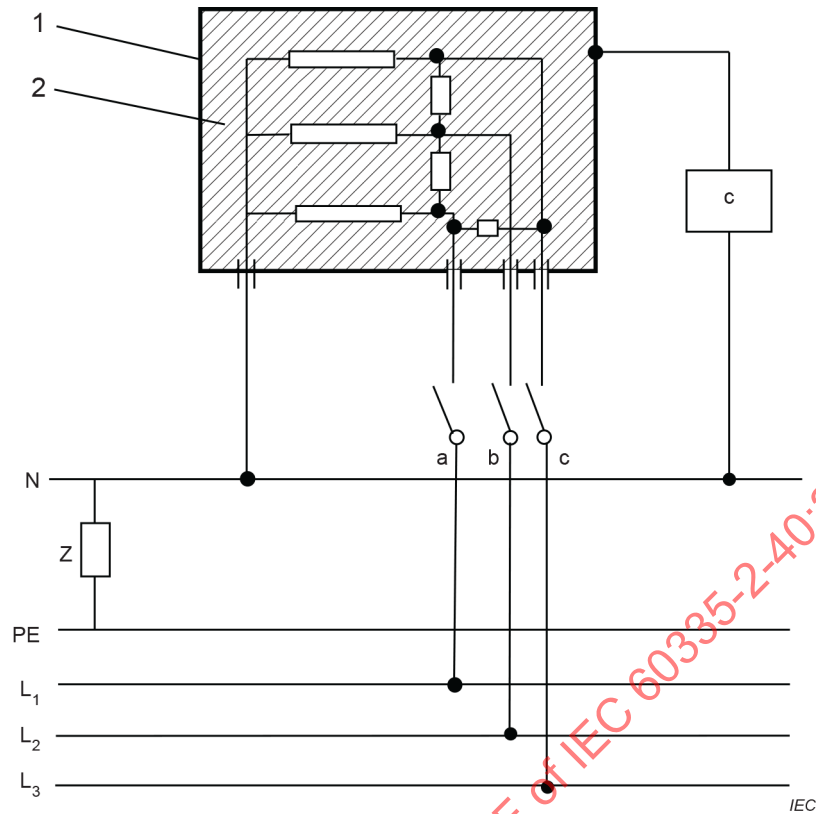
1 **accessible part**2 **inaccessible metal part**3 **basic insulation**4 **supplementary insulation**5 **double insulation****Connections and supplies** L_1, L_2, L_3, N supply voltage with neutral

PE protective earth conductor

Z IT system neutral to earth high impedance

NOTE If the test laboratory is supplied from a TN or TT distribution system, then Z will be zero. Consequently, always connecting "C" to the neutral conductor will ensure reproducibility of the test result regardless of the type of distribution system (TN, TT or IT) used by the test laboratory and will cover the most onerous condition likely to be encountered during normal use of the appliance.

Figure 3 – Circuit diagram for leakage current measurement at operating temperature for three-phase with neutral class II appliances and for parts of class II construction



Key

C circuit of Figure 4 of IEC 60990:2016

1 accessible part

2 basic insulation

Connections and supplies

L_1, L_2, L_3, N Supply voltage with neutral

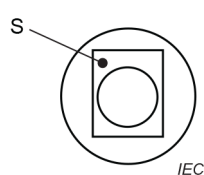
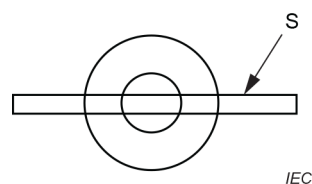
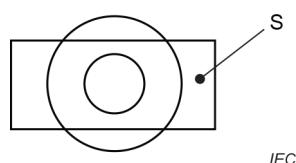
PE protective earth conductor

Z IT system neutral to earth high impedance

NOTE 1 For **class 0I appliances** and **class I appliances**, C can be replaced by a low impedance ammeter responding to the **rated frequency** of the appliance.

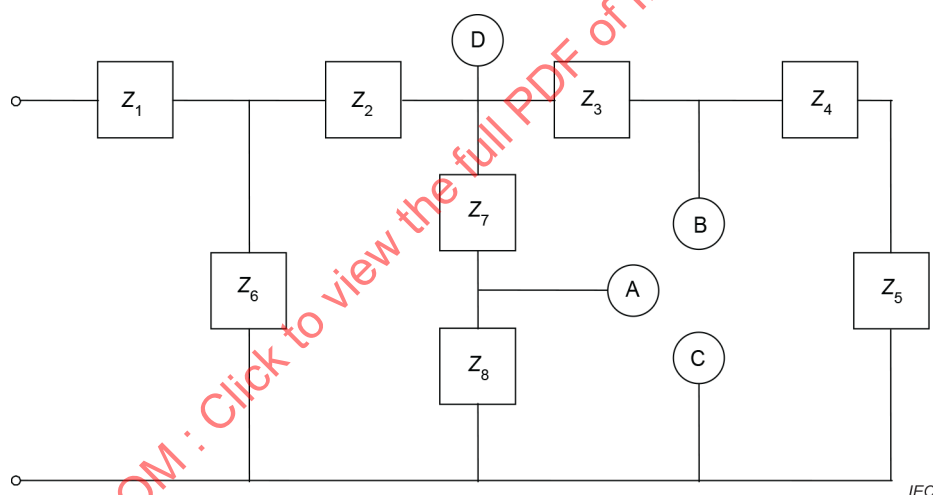
NOTE 2 If the test laboratory is supplied from a TN or TT distribution system, < then Z will be zero. Consequently, always connecting "C" to the neutral conductor will ensure reproducibility of the test result regardless of the type of distribution system (TN, TT or IT) used by the test laboratory and will cover the most onerous condition likely to be encountered during normal use of the appliance.

Figure 4 – Circuit diagram for leakage current measurement at operating temperature for three-phase with neutral appliances other than those of class II or parts of class II construction

a) Example of a **small part**b) Example of a **small part**c) Example of a part that is not a **small part****Key**

S surface

NOTE The small and large circles in examples A, B and C are 8 mm and 15 mm in diameter respectively.

Figure 5 – Small part

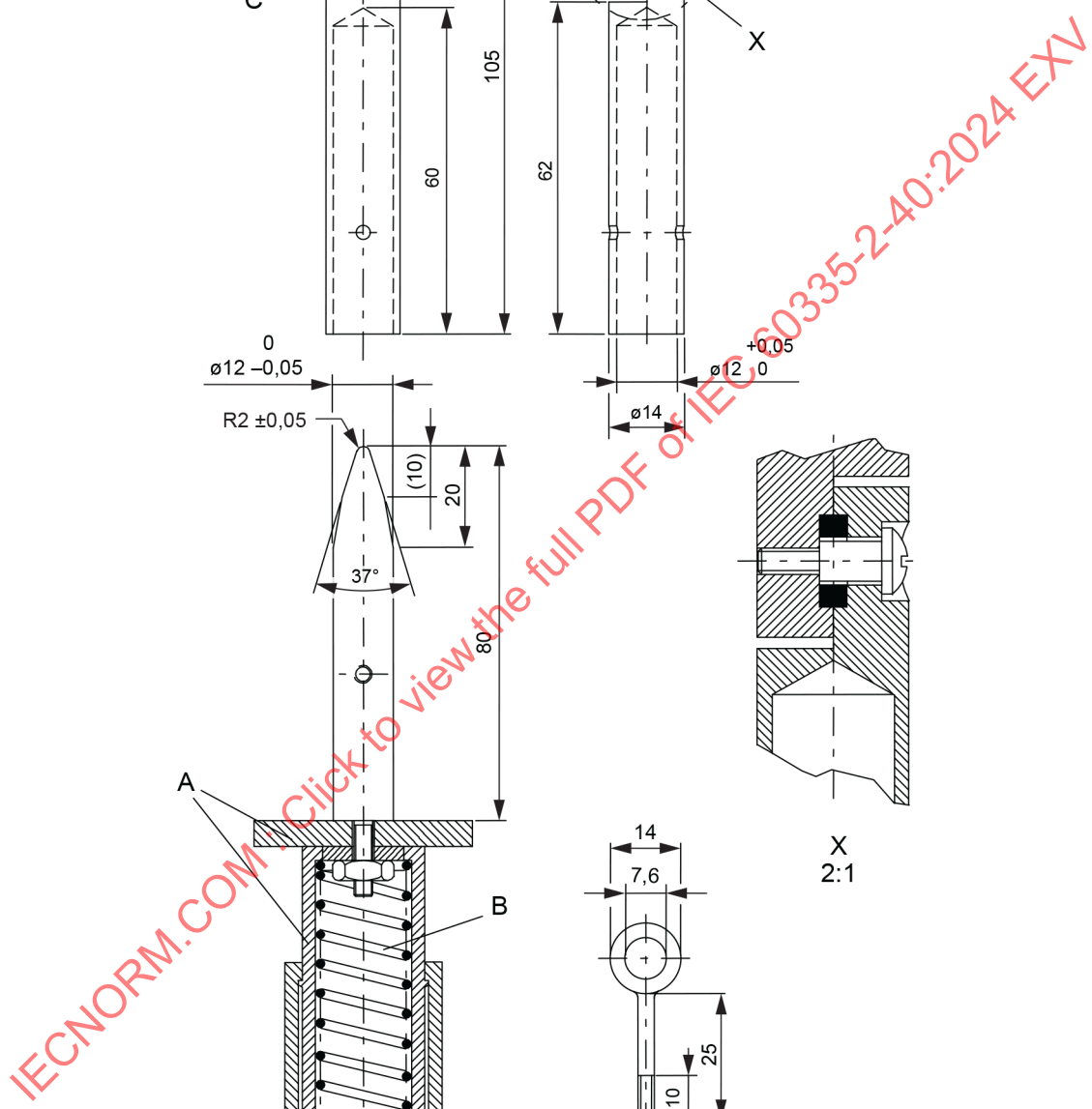
D is a point farthest from the supply source where the maximum power delivered to external load exceeds 15 W.

A and B are points closest to the supply source where the maximum power delivered to external load does not exceed 15 W. These are low-power points.

Points A and B are separately short-circuited to C.

The fault conditions a) to g) specified in 19.11.2 are applied individually to Z_1 , Z_2 , Z_3 , Z_6 and Z_7 , where applicable.**Figure 6 – Example of an electronic circuit with low-power points**

Dimensions in millimetres

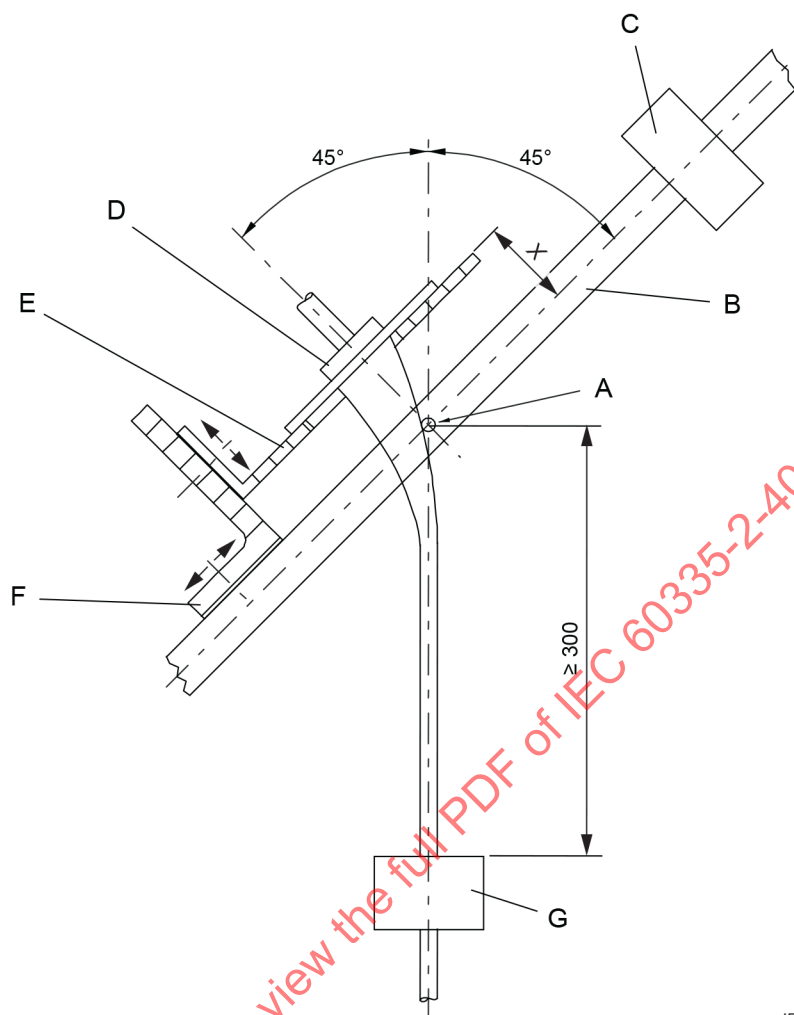


Key

- A insulating material
B spring with a constant suitable for providing a push force as specified in 22.11 on the test finger nail
C loop

Figure 7 – Test finger nail

Dimensions in millimetres



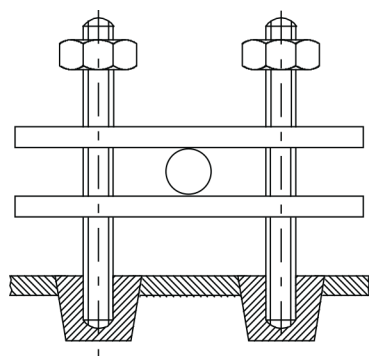
IEC

Key

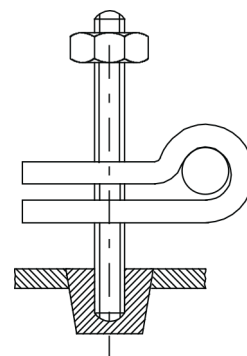
- A axis of oscillation
- B oscillating frame
- C counterweight
- D sample
- E adjustable carrier plate
- F adjustable bracket
- G load

Figure 8 – Flexing test apparatus

ACCEPTABLE CONSTRUCTIONS

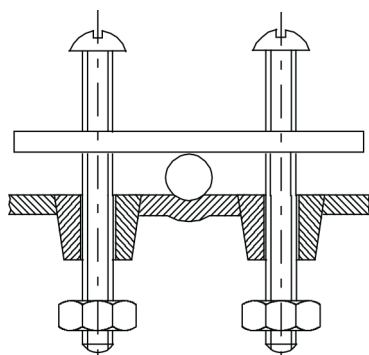


IEC

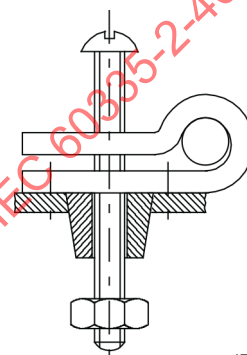


IEC

Construction showing studs securely attached to the appliance



IEC



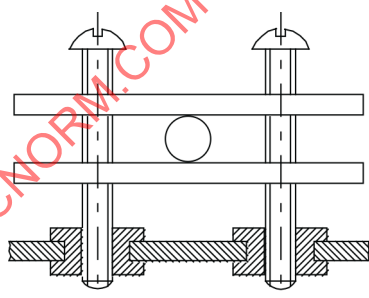
IEC

Construction showing part of appliance of insulating material and so shaped that it obviously forms part of a cord clamp.

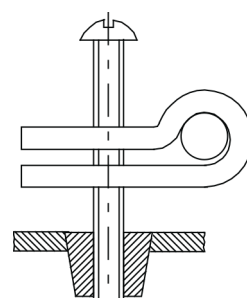
Construction showing one of the clamping members is fixed to the appliance

NOTE 1 Clamping screws can screw into threaded holes in the appliance or pass through holes where they are secured by nuts.

UNACCEPTABLE CONSTRUCTIONS



IEC

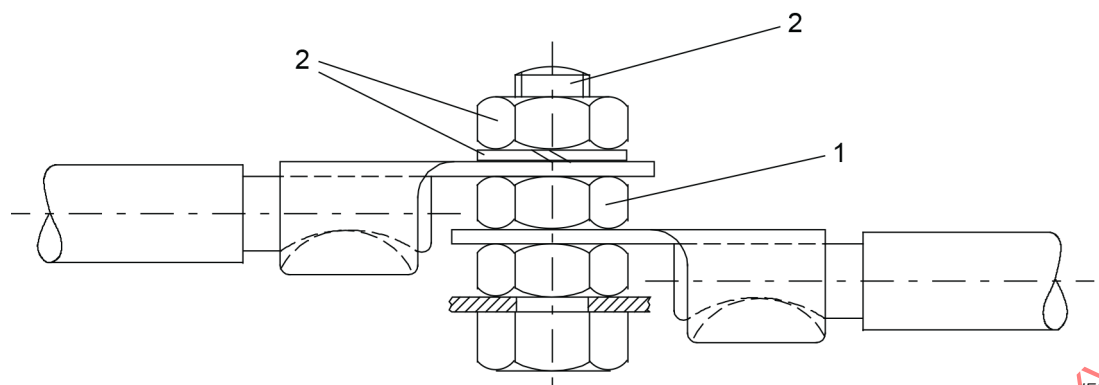


IEC

Construction showing no part securely fixed to the appliance

NOTE 2 Clamping screws can screw into threaded holes in the appliance or pass through holes where they are secured by nuts.

Figure 9 – Constructions of cord anchorages

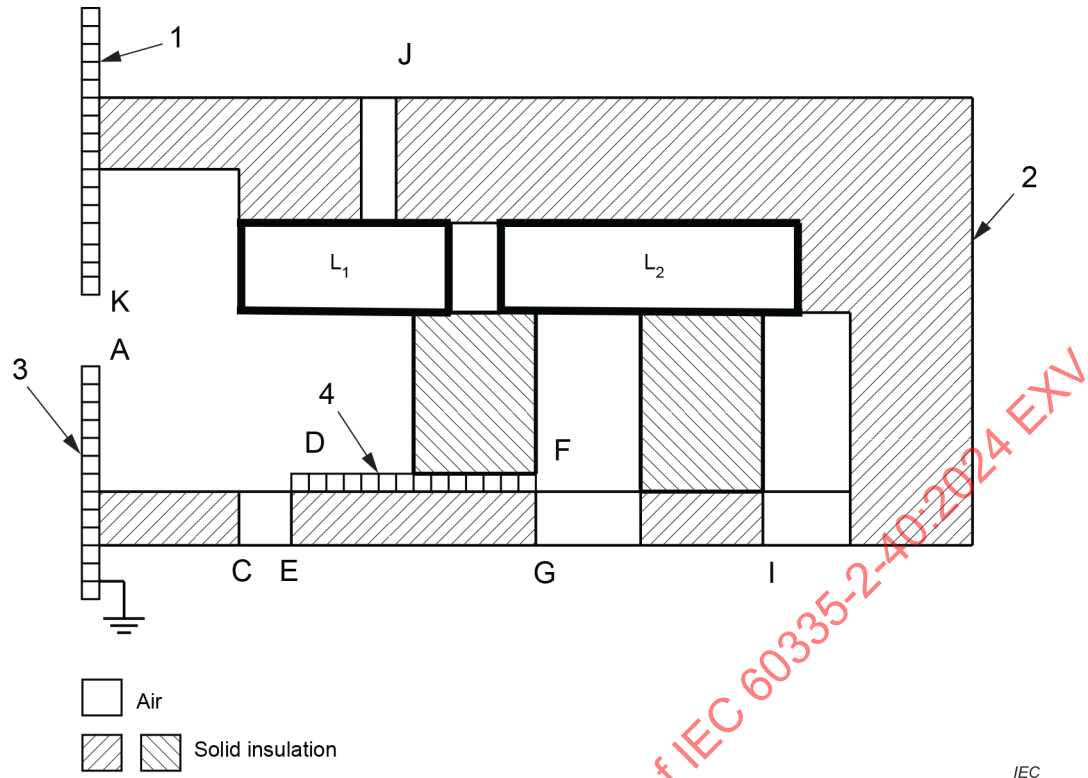


Key

- 1 part providing earthing continuity
- 2 part providing or transmitting contact pressure

Figure 10 – An example of parts of an earthing terminal

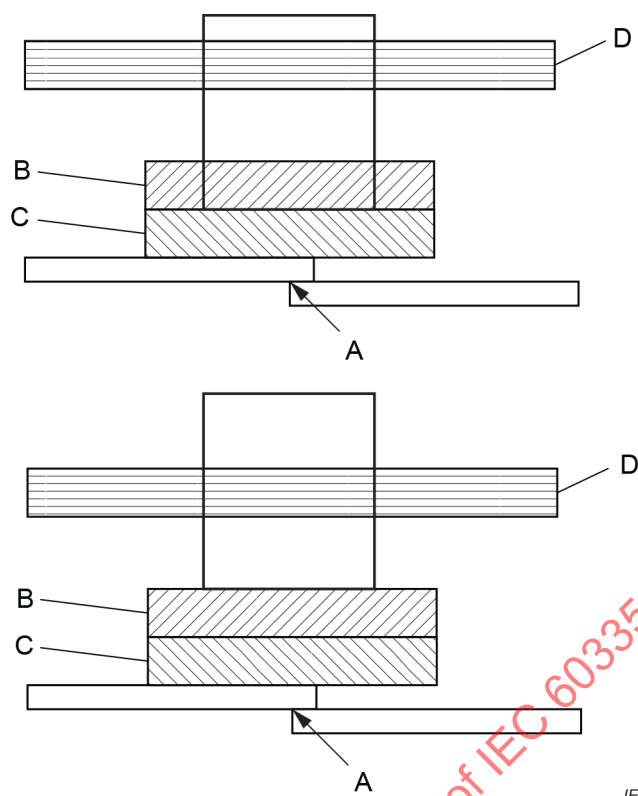
IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV



Type of insulation	Clearance
Basic insulation	L_1A
	L_1D
	L_2F
Functional insulation	L_1L_2
Supplementary insulation	DE
	FG
Reinforced insulation	L_1K
	L_1J
	L_2I
	L_1C

NOTE If the **clearances** L_1D or L_2F meet the **clearance** requirements for **reinforced insulation**, the **clearances** DE or FG of **supplementary insulation** are not measured.

Figure 11 – Examples of clearances



Key

- A connection zone
- B non-metallic material
- C non-metallic material
- D non-metallic material

NOTE 1 The placement of the cylinder is shown with respect to example 1 in Figure O.5.

NOTE 2 If C flames for longer than 2 s during the glow-wire test, then the cylinder is assumed to be located at the upper boundary of C. Consequently parts B and D are subjected to the needle-flame test.

If B flames for longer than 2 s during the glow-wire test, then the cylinder is assumed to be located on top of B. Consequently, D is subjected to the needle-flame test.

NOTE 3 In some constructions, D can be another part of the same moulding as B or C. Therefore, if B or C flame for longer than 2 s during the glow-wire test, the material used for B or C that is within the cylinder, represented by D, is also subjected to the needle-flame test.

Figure 12 – Example of the placement of the cylinder

Dimensions in millimetres

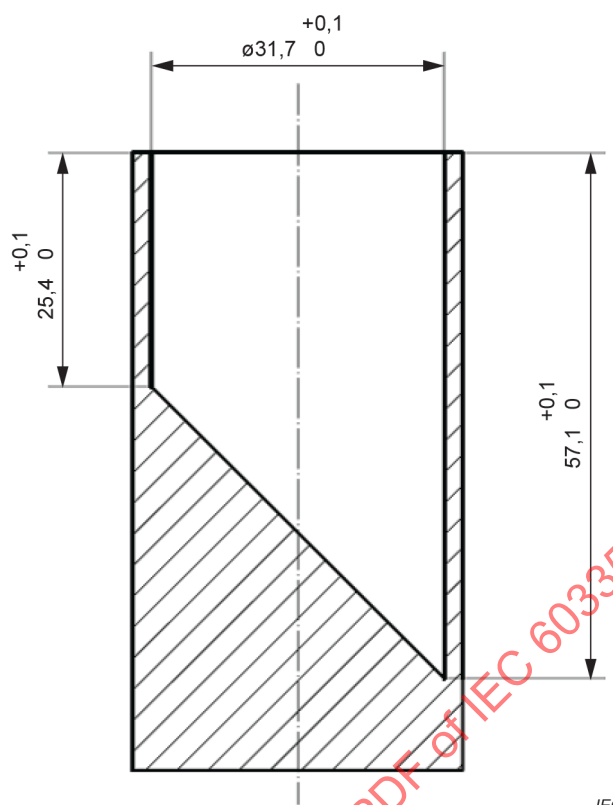
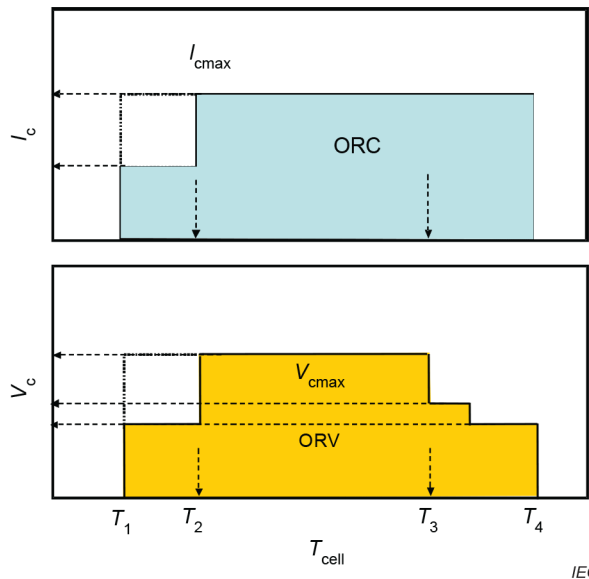
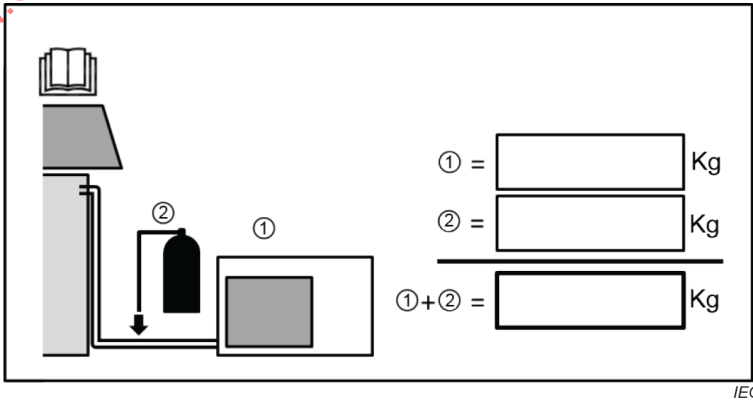


Figure 13 – Small parts cylinder



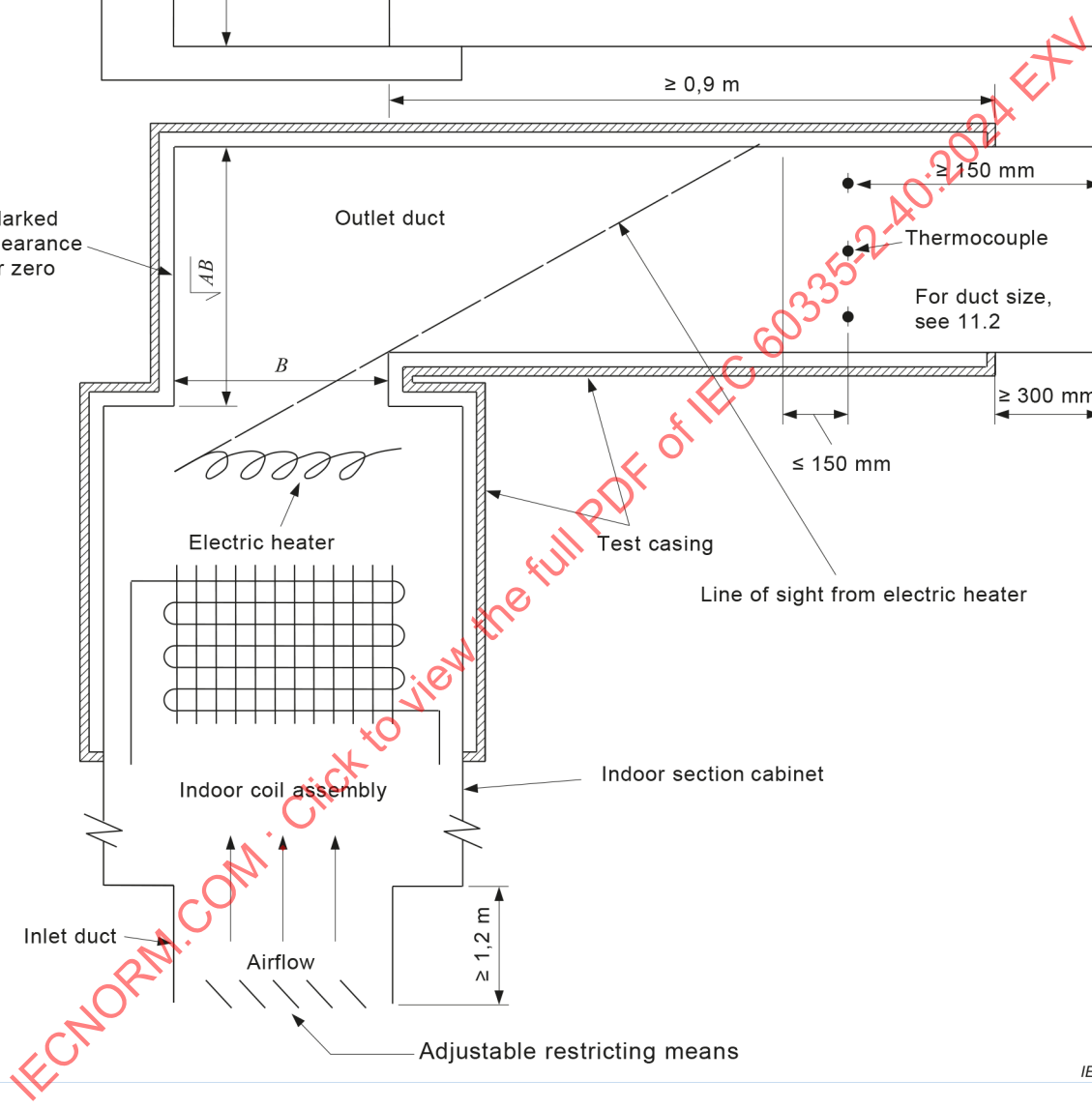
- Key**
- T_1 to T_2 low temperature range
 - T_2 to T_3 standard temperature range
 - T_3 to T_4 high temperature range
 - ORC operating region (current)
 - I_{cmax} maximum charging current
 - I_c charging current
 - ORV operating region (voltage)
 - V_{cmax} upper limit charging voltage
 - V_c charging voltage
 - T_{cell} cell surface temperature

Figure 14 – Example of a specified operating region of a lithium-ion cell during charging



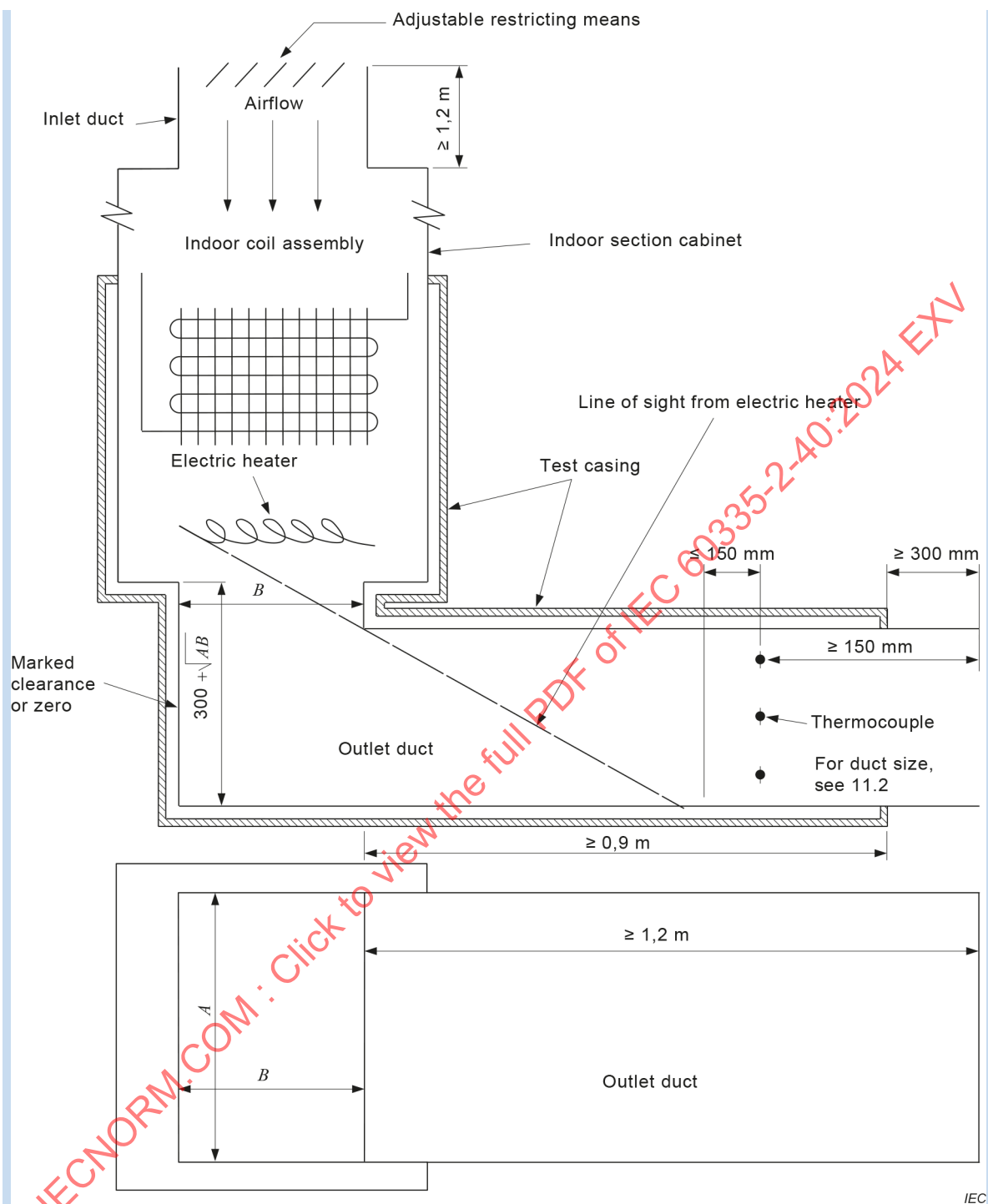
- Key**
- Example 1 **refrigerant charge** of the precharged part of the appliance
 - Example 2 **refrigerant charge** added during installation

Figure 101 – Example of label for field charged units



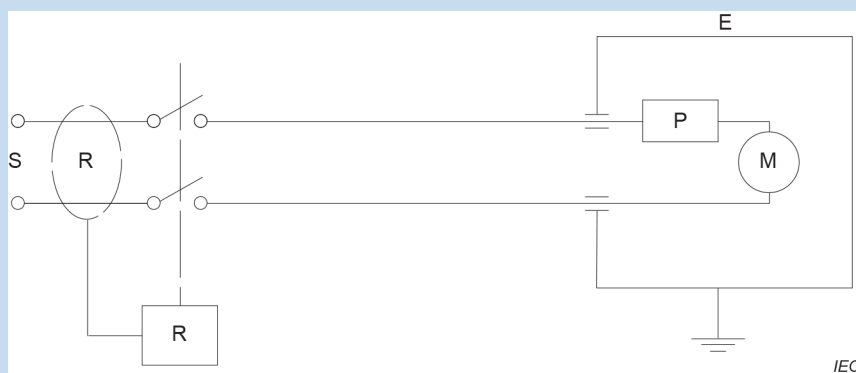
IEC

a) Upflow application



b) Downflow application

Figure 102 – Arrangement for heating test of appliances with supplementary air heater



Key

S supply

E motor enclosure

R residual current device ($I_{\Delta n} = 30 \text{ mA}$)
(RCCB or RCBO)

P **protective device** (external or internal)

M motor

NOTE The figure can be revised as necessary for three-phase test.

Figure 103 – Supply circuit for locked-rotor test of a motor of the single-phase type

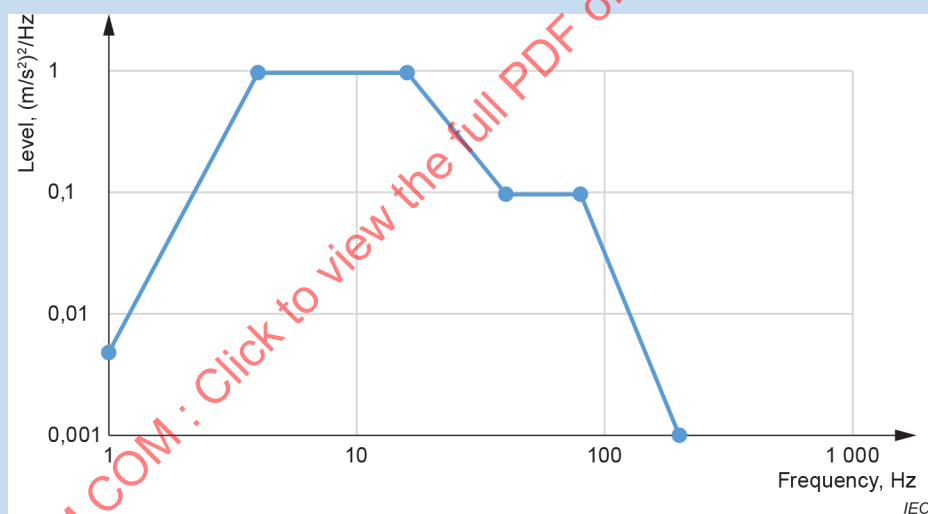


Figure 104 – Power spectral density profile for vibration test in 21.101

Dimensions in millimetres

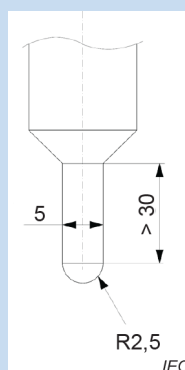


Figure 105 – Dimensional details for the weight in the area of the pressure ball

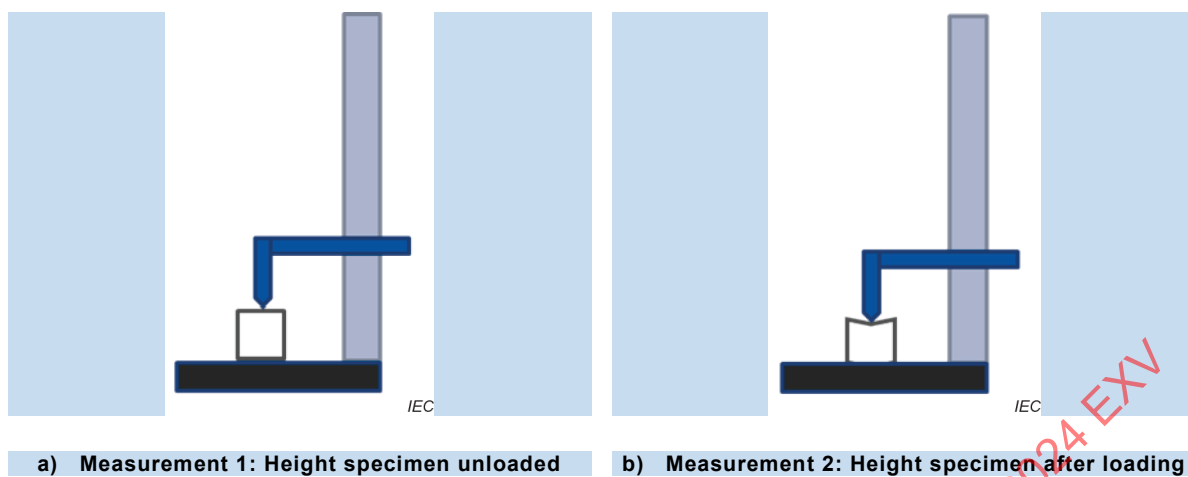


Figure 106 – Measurement before and after the test

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex A (informative)

Routine tests

A.1 Overview

Routine tests are intended to be carried out by the manufacturer on each appliance to detect a production variation that could impair safety. They are normally carried out on the complete appliance after assembly but the manufacturer may perform the tests at an appropriate stage during production, provided that later manufacturing processes do not affect the results.

Components are not subjected to these tests if they have been previously subjected to routine tests during their manufacture.

The manufacturer may use a different routine test procedure provided that the level of safety is equivalent to that provided by the tests specified in this annex.

These tests are the minimum considered necessary to cover essential safety aspects. It is the manufacturer's responsibility to decide if additional routine tests are necessary. It may be determined from engineering considerations that some of the tests are impracticable or inappropriate and therefore need not be carried out.

If a product fails any of the tests, it is to be retested after rework or adjustment.

A.2 Earth continuity test

*A current of at least 10 A, derived from a source having a no-load voltage not exceeding 12 V (AC or DC), is passed between each of the **accessible earthed metal parts** and for:*

- **class 0I appliances**, and for **class I appliances** intended to be permanently connected to fixed wiring, the earthing terminal;
- **other class I appliances**:
 - the earthing pin or earthing contact of the plug;
 - the earthing pin of the appliance inlet.

The voltage drop is measured and the resistance is calculated and shall not exceed for:

- appliances having a **supply cord**, 0,2 Ω , or 0,1 Ω plus the resistance of the **supply cord**;
- other appliances, 0,1 Ω .

The duration of the current flow is that required to enable the voltage drop to be measured.

A.3 Electric strength test

The insulation of the appliance is subjected to a voltage of substantially sinusoidal waveform having a frequency of approximately 50 Hz or 60 Hz for 1 s. The value of the test voltage and the points of application are shown in Table A.1.

Table A.1 – Test voltages

Points of application	Test voltage		
	V		
	Class 0 appliances, Class 0I appliances, Class I appliances and Class II appliances		Class III appliances
	Rated voltage		
	≤ 150 V	> 150 V	
Between live parts and accessible metal parts separated from live parts by			
• basic insulation only	800	1 000	400
• double or reinforced insulation ^{a, b}	2 000	2 500	—
^a This test is not applicable for class 0 appliances .			
^b For class 0I appliances and class I appliances , this test need not be carried out on parts of class II construction if the test is considered to be inappropriate.			

It may be necessary for the appliance to be in operation during the test to ensure that the test voltage is applied to all relevant insulation, for example, heating elements controlled by a relay.

Instead of being subjected to an AC voltage, the insulation may be subjected to a DC voltage of 1,5 times the value shown in the table. An AC voltage having a frequency up to 5 Hz is considered to be a DC voltage.

No breakdown shall occur. Breakdown is assumed to occur when the current in the test circuit exceeds 5 mA. However, this limit may be increased up to 30 mA for appliances with a high leakage current.

The circuit used for the test should incorporate a current sensing device that trips when the current exceeds the limit. The high voltage transformer should be capable of maintaining the specified voltage at the limiting current.

A.4 Functional test

The correct functioning of an appliance is checked by inspection or by an appropriate test if the incorrect connection or adjustment of components has safety implications.

NOTE Examples are verification of the correct direction of motor rotation and the appropriate operation of interlock switches. This does not require testing of thermal controls or **protective devices**.

Annex B (normative)

Battery-operated appliances, separable batteries and detachable batteries for battery-operated appliances

The following modifications to this standard are applicable to:

- **battery-operated appliances** and remote controls employing **non-rechargeable batteries** (primary **batteries**);
- **battery-operated appliances** and remote controls employing **batteries** that are rechargeable (secondary **batteries**);
- **detachable batteries** and **separable batteries** for **battery-operated appliances**.

The clause numbers in this Annex refer to the clause numbers in the main part of this standard that are modified or not applicable. Clauses that are additional to the clauses in the main part of this standard are identified by adding the Annex letter with the numbering starting at 1.

NOTE 1 This annex does not apply to battery chargers (IEC 60335-2-29) (See Figure B.1 e). When used in conjunction with the word charger, battery is not a defined term so is not bolded.

NOTE 2 When supplied in parts, the complete appliance is the **detachable power supply part**:

- plus the part of the appliance containing the **battery** and the **battery** charging circuitry (Figure B.1 b);
- with the **battery** charging circuitry plus the part of the appliance containing the **battery** (see Figure B.1 c and d); or
- with the **battery** charging circuitry plus the **separable battery** and the part of the appliance performing the intended function (see Figure B.1 f).

An overview on the different configurations is given in Figure B.1.

NOTE 3 As the requirements in this annex are based on **battery systems** that use lithium-ion chemistry, other metal-ion and newer chemistries can have characteristics and performance not fully contemplated by these requirements or those of the referenced **battery** standard.

3 Terms and definitions

B.3.1 Definitions relating to physical characteristics

B.3.1.1

normal operation

battery-operated appliances are operated under the following conditions:

- for appliances operated with **detachable batteries** or **separable batteries** that are disconnected from the appliance for charging purposes, the appliance is operated to perform its intended function with a **battery** that is **fully charged**. The **battery** being the model or type reference of the **battery** provided or indicated in the instructions;
- for appliances operated with **integral batteries** or **separable batteries** not disconnected from the appliance for charging purposes, and that cannot perform their intended function while the **batteries** are being charged, the appliance is operated to perform its intended function with a **battery** that is **fully charged**;
- for appliances operated with **batteries** that are replaceable, including **integral batteries** that are replaceable, or **non-rechargeable batteries**, the appliance is operated to perform its intended function with the artificial source described in B.5.3 with the specified upper limit short circuit current capacity I_{sc} (high) as indicated in Table B.1.

Note 1 to entry: Operation of the appliance to perform its intended function is specified in the relevant part 2.

B.3.6 Definitions relating to parts of an appliance

B.3.6.1

non-rechargeable battery

battery that is supplied in a **fully charged** state and cannot be recharged thereafter

5 General conditions for the tests

5.2 *The tests of subclauses B.19.1 to B.19.6 may be carried out on separate samples.*

5.8.1 This subclause is not applicable.

5.8.2 This subclause is not applicable.

5.8.3 This subclause is not applicable.

5.8.4 This subclause is not applicable.

B.5.1 *Before starting a test requiring a **battery** that is **fully charged**, the **battery** shall be **fully charged** and then shall be disconnected from the charging source and allowed to rest for at least 2 h but no more than 6 h.*

B.5.2 *Whenever a **rated voltage** is specified, a **battery** that is **fully charged** shall be used.*

*For **battery-operated appliances**, where the supply terminals for the connection of the **battery** have no indication of polarity, the more unfavourable polarity shall be applied unless such a connection is unlikely to occur due to the construction of the appliance.*

B.5.3 *Where it is specified in the requirements that the **battery** provided with or intended for the appliance may be replaced with an artificial source, that source shall consist of a DC power supply or a specially constructed **battery**, the output of each having the characteristics described in Table B.1 for the relevant **battery** type.*

Table B.1 – Artificial source characteristics

Battery type	Initial open circuit voltage V ± 10 %	I_{sc}^a (low) A +0 % –25 %	I_{sc}^a (high) A +25 % –0 %	Minimum capacity Ah ^c	(Informative) IEC References^b
Rechargeable	Fully-charged battery voltage	$0,5 \times I_{sc}$ of battery provided	$2,0 \times I_{sc}$ of battery provided	300 % of capacity of battery provided measured at 1 A and 0,9 V/cell cut-off	
Non-rechargeable AAA ^d	1,5	3	10	0,5	LR03
Non-rechargeable AA ^d	1,5	5	15	1,0	LR6
Non-rechargeable C ^d	1,5	5	15	3,0	LR14
Non-rechargeable D ^d	1,5	6	20	10	LR20
Non-rechargeable PP3 ^d (9 V)	9,0	0,6	6	0,5	6LR61
Non-rechargeable (other)	Nominal battery voltage	$0,5 \times I_{sc}$ of battery provided	$2,0 \times I_{sc}$ of battery provided	200 % of capacity of battery provided measured at 1 A and 0,9 V/cell cut-off	-
NOTE 1 I_{sc} limits are specified for those batteries likely to be replaced with others of the same type but of differing performance. NOTE 2 The specified Ah values are based upon nominal 1 A discharge current with a 0,9 V/cell end-of-discharge voltage except for PP3 (9 V), which is based upon 0,1 A discharge current with a 0,9 V/cell end-of-discharge voltage. NOTE 3 As used in this table, "provided" means either the battery that is provided with the appliance or, if not provided, the battery that is intended or specified to be used with the appliance. ^a The short circuit current is measured after 1 s ± 0,2 s into a resistance of 10 mΩ ± 2 mΩ. Care shall be taken to ensure that self-heating of the resistance is managed to minimize the variability on the current during the tests. ^b References are taken from IEC 60086-1. ^c If the measured capacity is less than 50 % of the capacity specified by the battery manufacturer, calculation of minimum capacity shall be based on the capacity specified by the battery manufacturer instead of measurement. ^d The non-rechargeable types specified are for alkaline types only.					

6 Classification

6.1 Battery-operated appliances without a supply connection or a functional earth connection are not classified with respect to protection against electric shock.

NOTE Potential for electric shock hazard is considered to exist only between parts of opposite polarity with no reference to earth.

Compliance is checked by inspection and the relevant tests.

7 Marking and instructions

7.1 Battery-operated appliances and remote controls containing **batteries** shall be marked with the:

- name, trade mark or identification mark of the manufacturer or responsible vendor;
- model or type reference;
- IP number according to degree of protection against ingress of water, other than IPX0;
- type reference of the **battery** if the **battery** is either not recharged in the appliance or is non-rechargeable.

Appliances incorporating **batteries** that are replaceable shall be marked with the **battery** type reference, **battery** voltage and the polarity of the terminals. Polarity marking is not required if incorrect insertion of the **battery** by the user is unlikely to occur due to the construction of the appliance.

If more than one **battery** type can be used with the appliance, the appliance shall be marked with the type reference of at least one of the **battery** types that can be used together with either the symbol ISO 7000-0790 (2004-01) or with the substance of the following:

See instruction manual for additional battery types.

If appliances use more than one **battery**, appliances shall be marked to indicate correct polarity connection of the **batteries**.

If relevant, the positive terminal shall be indicated by symbol IEC 60417-5005 (2002-10) and the negative terminal by symbol IEC 60417-5006 (2002-10).

Examples of acceptable marking of an appliance using three **batteries** are shown in Figure B.2.

Detachable batteries and **separable batteries** shall be marked with the:

- name, trade mark or identification mark of the manufacturer or responsible vendor;
- model or type reference;
- IP number according to degree of protection against ingress of water, other than IPX0.

Detachable batteries and **separable batteries** that are disconnected from the appliance for charging the **battery** shall be marked with symbol ISO 7000-0790 (2004-01). They shall also be marked with symbol IEC 60417-6413 (2019-05) and the model or type reference of the battery charger or with the substance of the following:

Use only with <model or type reference> battery charger.

If more than one battery charger can be used to charge a **detachable battery** and **separable battery** that is disconnected from the appliance for charging, the **battery** shall be marked with the type reference of at least one of the battery chargers that can be used together with either the symbol ISO 7000-0790 (2004-01) or with the substance of the following:

See instruction manual for additional battery chargers.

Batteries that are user replaceable, other than general purpose **batteries**, shall be marked with the:

- name, trade mark or identification mark of the manufacturer or responsible vendor;
- model or type reference;
- nominal voltage.

NOTE Examples of general purpose **batteries** are AAA, AA, C and D alkaline **batteries** and some lead-acid **batteries**.

Compliance is checked by inspection.

7.6

	[symbol IEC 60417-5005 (2002-10)]	plus; positive polarity
	[symbol IEC 60417-5006 (2002-10)]	minus; negative polarity
	[symbol IEC 60417-6413 (2019-05)]	battery charger

7.12 Instructions shall be provided with the appliance so that the appliance can be used safely.

For appliances intended for use at altitudes exceeding 2 000 m, the maximum altitude of use shall be stated.

If it is necessary to take precautions during **user maintenance**, appropriate details shall be given.

The instructions shall state the substance of the following:

This appliance is not intended for use by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction concerning use of the appliance by a person responsible for their safety.

Children should be supervised to ensure that they do not play with the appliance.

The instructions for appliances incorporating **batteries** that are intended to be removed for charging or are intended to be replaced by the user and that can be contained in the small parts cylinder in Figure 13 shall state the substance of the following:

WARNING: Keep out of reach of children. Swallowing can lead to chemical burns, perforation of soft tissue, and death. Severe burns can occur within 2 h of ingestion. Seek medical attention immediately.

For appliances intended for use with **batteries** that use metal-ion chemistries, the instructions shall state the normal temperature range for charging the **battery**.

The instructions for **battery-operated appliances** shall contain the following information, as applicable:

- the **battery** type;
- details regarding safe disposal of used **batteries**;
- how to deal with leaking **batteries**.

The instructions for **battery-operated appliances** shall contain the substance of the following:

- do not expose the appliance or battery to excessive temperatures;
- be aware of the risk of terminals of the battery-operated appliance or battery being short-circuited by metal objects.

Instructions for **battery-operated appliances** containing **non-rechargeable batteries** shall state the substance of the following:

This appliance contains non-rechargeable batteries, these batteries are not to be recharged.

Instructions for **battery-operated appliances** containing **batteries** that are non-user-replaceable shall state the substance of the following:

This appliance contains batteries that are only replaceable by skilled persons.

Instructions for **battery-operated appliances** containing **batteries** that are non-replaceable shall state the substance of the following:

This appliance contains batteries that are non-replaceable. When the battery is at end of life, the appliance shall be properly disposed of.

The instructions for **battery-operated appliances** incorporating **batteries** intended to be removed for charging or replaced by the user shall include, as applicable, the substance of the following:

- rechargeable batteries are to be removed from the appliance before being charged;
- different types of batteries or new and used batteries are not to be mixed;
- exhausted batteries are to be removed from the appliance and safely disposed of;
- if the appliance is to be stored unused for a long period, the batteries should be removed;
- do not use non-rechargeable batteries in place of rechargeable batteries;
- do not use modified or damaged batteries.

The instructions for **battery-operated appliances** incorporating **batteries** intended to be removed for charging or replaced by the user shall include, as applicable, the following information:

- the **battery** type reference;
- the orientation of the **battery** with regard to polarity;
- the method of replacing **batteries** including maintaining correct polarity.

The instructions for **battery-operated appliances** incorporating **batteries** that are intended to be removed prior to disposal of the appliance shall include details regarding their safe removal and disposal.

The instructions for **battery-operated appliances** that use **detachable batteries** and **separable batteries** that are disconnected from the appliance for charging the battery shall include the model or type reference of the battery charger to be used along with the substance of the following:

WARNING: Use only with <model or type reference> battery charger.

If the symbol for battery charger is used, its meaning shall be explained.

NOTE Instructions can be marked on the appliance as long as they are visible in normal use.

7.15 The marking specified for **batteries** intended to be replaced by the user shall be in or adjacent to the **battery** compartment.

The marking to indicate correct polarity connection of the **batteries** specified for appliances using more than one general purpose **battery** (**battery** not designed or sold for a specific purpose) shall be in or adjacent to the **battery** compartment.

The type reference of the battery charger shall be placed next to symbol IEC 60417-6413 (2019-05).

8 Protection against access to live parts

This clause is not applicable to the appliance functional part of a **battery-operated appliance** and its **batteries**, providing the **battery** circuits do not have an earth connection or mains connection.

NOTE 1 The requirements for parts requiring protection against simultaneous contact are specified in B.22.3 and B.22.4.

NOTE 2 The term appliance functional part is illustrated in Figure B.1.

10 Power input and current

10.1 This subclause is not applicable.

10.2 This subclause is not applicable.

11 Heating

11.1 **Battery-operated appliances**, their surroundings, and **batteries** shall not attain excessive temperatures in normal use.

Compliance is checked by determining the temperature rise of the various parts under the conditions specified in B.11.1, 11.2, 11.3, 11.7, and 11.8.

11.4 This subclause is not applicable.

11.5 This subclause is not applicable.

11.6 This subclause is not applicable.

B.11.1 Battery-operated appliances are tested under the conditions of **normal operation**.

*For appliances operated with **detachable batteries** or **separable batteries** that are disconnected from the appliance for charging purposes, the appliance is operated until it no longer operates due to depletion of the **battery**. On the completion of the test, the depleted **battery** is immediately replaced with another **battery** that is **fully charged**, the **battery** being the model or type reference of the **battery** provided or indicated in the instructions. The test is repeated until the appliance no longer operates due to depletion of the **battery** or until the temperature rises have stabilized to values not more than 5 K higher than the temperature rises measured at the same locations during the first test, whichever occurs first.*

*For appliances incorporating **integral batteries** or **separable batteries** not disconnected from the appliance for charging purposes, and that cannot perform their intended function while the **batteries** are being charged, the appliance is operated continuously until it cannot perform its intended function due to the depletion of the **batteries**.*

*For appliances operated with **batteries** that are replaceable or **non-rechargeable batteries**, the appliance is operated until the minimum capacity of the **battery** as specified in Table B.1 has been delivered or until steady conditions are established, whichever occurs first.*

19 Abnormal operation

19.1 For **battery-operated appliances**, instead of the tests specified, compliance is checked by the tests of 19.2, 19.4, 19.7, 19.9, 19.11, 19.12, 19.14, 19.15, B.19.1 to B.19.5.

Detachable batteries and separable batteries are also subjected to the test of B.19.6.

For **battery-operated appliances**, the tests are carried out under **normal operation**.

19.2 Appliances with heating elements are tested under the conditions specified in Clause 11 but with restricted heat dissipation.

NOTE Controls that operate during the test of Clause 11 are allowed to operate.

19.7 The **battery-operated appliance** is switched on and operated under stalled conditions by:

- locking the rotor of appliances for which the locked rotor torque is smaller than the full load torque;
- locking moving parts of other appliances.

If an appliance has more than one motor, the test is carried out for each motor separately.

The test is conducted at both I_{sc} (high) and I_{sc} (low), if testing with the artificial source described in B.5.3.

The test is conducted:

- until the test sample achieves a steady condition, including returning to **room temperature**; or
- until at a time period of at least 3 h has elapsed.

19.11 Electronic circuits are checked by evaluation of the fault conditions specified in 19.11.2 for all circuits or parts of circuits, unless they comply with the conditions specified in 19.11.1.

NOTE 1 In general, examination of the appliance and its circuit diagram will reveal the fault conditions which have to be simulated, so that testing can be limited to those cases that may be expected to give the most unfavourable results.

Appliances having a device with an **off position** obtained by electronic disconnection, or a device that can place the appliance in a stand-by mode, are subjected to the tests of 19.11.4.

NOTE 2 For information on general guidance relating to the sequence of tests for the evaluation of **electronic circuits**, reference is made to informative Annex Q. It is noted that in the parts 2 there may be additional or alternative abnormal operation tests specified; these are not shown in the flow chart. For correct application of this standard, the normative text takes precedence over the guidance given in informative Annex Q.

If the safety of the appliance under any of the fault conditions depends on the operation of a miniature fuse-link complying with IEC 60127, the test of 19.12 is carried out. The appliance shall comply with the conditions specified in 19.13.

If a conductor of a printed circuit board becomes open-circuited, the appliance is considered to have withstood the particular test, provided that the base material of the printed circuit board withstands the test of normative Annex E.

19.11.2 When any of the fault conditions are simulated, the duration of the test is until steady conditions are established.

19.11.4 Appliances having a device with an **off position** obtained by electronic disconnection, or a device that can be placed in the stand-by mode, are subjected to the tests of 19.11.4.1 and 19.11.4.2. The tests are carried out with the appliance supplied by a **battery** that is **fully charged**, the device being set in the **off position** or in the stand-by mode.

Appliances incorporating a **protective electronic circuit** are subjected to the tests of 19.11.4.1 and 19.11.4.2. The tests are carried out after the **protective electronic circuit** has operated during the relevant tests of Clause 19 except 19.2 and 19.11.3.

19.11.4.8 Battery operated appliances are supplied with a **battery** that is **fully charged** and operated under **normal operation** for approximately 60 s, and then subjected to a 60 s interruption of the **battery** current. When the **battery** current is restored, the appliance shall:

- continue to operate normally from the same operating cycle point reached before the **battery** supply was interrupted; or
- not continue operating without requiring manual intervention to restart from the same operating cycle point reached before the **battery** supply was interrupted; or
- not continue operating without requiring manual intervention to restart from the part of the cycle selected by the user.

19.13 During the tests, the appliance shall not emit flames, molten metal, or poisonous or ignitable gas in hazardous amounts and temperature rises shall not exceed the values shown in Table 9. No explosion or ignition of the **battery** shall occur during or after the test.

Venting of the **cells** is permitted provided that they have not vented by any means other than through their vents.

NOTE 1 Gas vented from **cells** is not considered to be poisonous or ignitable in hazardous amounts.

After the tests, and when the appliance has cooled to approximately **room temperature**, compliance with B.22.3 and B.22.5 shall not be impaired and the appliance shall comply with 20.2 and Clause 29, if it can still be operated.

Table 9 – Maximum abnormal temperature rise

Part	Temperature rise K
Wooden supports, walls, ceiling and floor of the test corner and wooden cabinets ^a	150
^a For motor-operated appliances , these temperature rises are not determined.	

For appliances which are immersed in or filled with conducting liquid in normal use, the appliance is immersed in or filled with water for 24 h before the test of B.22.5 is carried out.

The appliance shall not undergo a **dangerous malfunction**, and there shall be no failure of **protective electronic circuits** if the appliance is still operable.

Appliances tested with an electronic switch in the **off position**, or in the stand-by mode, shall:

- not become operational; or
- if they become operational, not result in a **dangerous malfunction** during or after the tests of 19.11.4.

NOTE 2 Unintended operation that can impair safety, can result from careless use of appliances, such as:

- storage of small appliances while connected to the supply;
- placing flammable material on working surfaces of **heating appliances**; or
- placing objects in areas near motorized appliances that are not expected to start.

In an appliance containing lids or doors that are controlled by one or more interlocks, one of the interlocks may be released provided that both of the following conditions are fulfilled:

- the lid or door does not move automatically to an open position when the interlock is released;
- the appliance will not restart after the cycle in which the interlock was released.

19.15 For **battery-operated appliances** incorporating a manual voltage selector switch intended to select **battery** voltage, this switch is set to the lowest voltage position and the highest voltage is applied.

B.19.1 The supply terminals of a **battery-operated appliance** having an indication of polarity are connected to the **battery** terminals of the opposite polarity, unless such a connection by the user is unlikely to occur due to the construction of the appliance.

B.19.2 For **battery-operated appliances** with provision for multiple **batteries**, one or more of the **batteries** shall be reversed and the appliance shall be operated, if reversal by the user of **battery** polarity is allowed by the construction.

B.19.3 For **battery-operated appliances** with motor(s), the terminals of each motor are short circuited one at a time, where the resistance of the short-circuit does not exceed 10 mΩ and with the appliance operating under the conditions of Clause 11. The test is conducted until steady conditions are achieved, including returning to **room temperature** or until a time period of at least 3 h has elapsed.

B.19.4 Appliances incorporating **batteries** that use metal-ion chemistries are tested as follows.

The test is conducted with all the **cells** of the **battery fully charged** and, for **batteries** consisting of more than one **cell**, one **cell fully discharged** on a **detachable battery** or **separable battery** connected to the appliance or on an appliance containing an **integral battery**.

The main discharge connections of the **battery** are shorted with a resistance not to exceed 10 mΩ. The test is conducted until a **non-self-resetting protection device** operates or an **intentionally weak part** becomes permanently open-circuited or until the test sample returns to **room temperature**.

NOTE The main discharge connections for **separable batteries** or **detachable batteries** are the **battery** terminals. For an **integral battery**, this is the output connection closest to the **cells** including their control circuitry.

B.19.5 The **battery-operated appliance** and any cords except supply cords, as appropriate, are tested with the **battery** connected, under the following fault conditions applied one at a time:

- any cord provided between the **battery-operated appliance** and a **separable battery** shall be short-circuited at the point along its length likely to produce the most adverse effects;
- for appliances having **batteries** that are replaceable and that can be removed without the aid of a **tool**, and having terminals that can be short-circuited by a thin straight bar, the terminals of the **battery** are short-circuited;
- charging terminals of the **battery-operated appliance** that are simultaneously accessible with the test probe 13 of IEC 61032 are short circuited so as to produce the most unfavourable result.

The **battery-operated appliance** is switched on and no additional mechanical load is applied. The tests are conducted until the test sample achieves a steady condition, including returning to **room temperature** or, until a time period of at least 3 h has elapsed. The resistance of the short circuit shall not exceed 10 mΩ.

B.19.6 **Detachable batteries** and **separable batteries** are tested under the following fault condition.

Combinations of **detachable battery** terminals and **separable battery** terminals simultaneously accessible by applying the test probe 13 of IEC 61032 are short circuited so as to produce the most unfavourable result. The resistance of the short circuit shall not exceed 10 mΩ.

20 Stability and mechanical hazards

B.20.1 The enclosure of a **battery-operated appliance** incorporating an **integral battery** that uses metal-ion chemistry shall withstand the pressure generated when a **cell** vents during failure.

Compliance is checked by inspection after the tests of Clause 19 for **batteries** with a capacity less than 0,2 Ah, and measurement in the case of a) or by the test of b).

- a) The total area of the unobstructed openings in the enclosure allowing gasses to pass shall be not less than the value specified in Table B.2; or
- b) a volume of air of the amount specified in Table B.3 shall be injected through a $(2,85 \pm 0,05)$ mm diameter orifice into the enclosure at an initial overpressure of $2\,070\text{ kPa} \pm 10\%$. Test fittings used for the test shall not increase the enclosure volume by more than 3 ml. The overpressure within the enclosure shall drop below 70 kPa within 30 s without any unintended rupturing damage to the enclosure

Table B.2 – Total area of openings for metal-ion cells

Capacity of the single metal-ion cell with the highest capacity Ah	Min. total area of openings mm ²
$0,2 \leq Ah < 5$	20
$5 \leq Ah < 25$	30
$25 \leq Ah < 100$	50
$Ah \geq 100$	100

Table B.3 – Volume of air injected at 2 070 kPa

Capacity of the single metal-ion cell with the highest capacity Ah	Volume of air ($\pm 10\%$) ml
$0,2 \leq Ah < 5$	20
$5 \leq Ah < 25$	30
$25 \leq Ah < 100$	50
$Ah \geq 100$	100

B.20.2 The enclosure of **detachable batteries** and **separable batteries** that use metal-ion chemistries shall withstand the pressure generated when a **cell** vents during failure.

Compliance is checked by inspection after the tests of Clause 19 for **batteries** with a capacity less than 0,2 Ah, and measurement in the case of a) or by the test of b).

- a) The total area of the unobstructed openings in the enclosure allowing gasses to pass shall be not less than the value specified in Table B.2; or

- b) a volume of air of the amount specified in Table B.3 shall be injected through a $(2,85 \pm 0,05)$ mm diameter orifice into the enclosure at an initial overpressure of $2\,070\text{ kPa} \pm 10\%$. Test fittings used for the test shall not increase the enclosure volume by more than 3 ml. The overpressure within the enclosure shall drop below 70 kPa within 30 s without any unintended rupturing damage to the enclosure.

21 Mechanical strength

21.1 Battery-operated appliances shall have adequate mechanical strength and shall be constructed to withstand such rough handling that may be expected in normal use.

Compliance is checked as follows.

The appliance fitted with **fully charged batteries** and rigidly supported is subject to test Ehb of IEC 60068-2-75. Three blows, each having an impact energy of 0,5 J, are applied to every point of the appliance enclosure that is likely to be weak.

If necessary, the blows are also applied to handles, levers, knobs and similar parts and to signal lamps and their covers but only if the lamps or covers protrude from the enclosure by more than 10 mm or if their surface area exceeds 4 cm^2 . Lamps within the appliance and their covers are only tested if they are likely to be damaged in normal use.

When applying the release cone to the guard of a **visibly glowing heating element**, the hammer head passing through the guard shall not strike the heating element.

If there is doubt as to whether a defect has occurred by the application of test Ehb of IEC 60068-2-75, this defect is neglected and the group of three blows is applied to the same place on a new sample which shall then withstand the test.

Hand-held battery-operated appliances shall also be subjected to test free-fall – procedure 1, of IEC 60068-2-31. They shall be dropped three times from a height of 1 m onto a concrete surface. The sample shall be positioned to vary the point of impact. **Batteries** shall be **fully charged** prior to the test. **Hand-held battery-operated appliances** employing **detachable batteries** are tested with and without the **detachable battery**.

Following the above tests, the appliance shall not catch fire, leak fluid that is visible from the outside of the appliance enclosure or explode and shall meet the requirements of Clause 20, Clause 29, B.22.3 and B.22.5 where short circuit of **functional insulation** will impair compliance with this standard.

Damage to the finish, small dents that do not reduce **clearances** or **creepage distances** below the values specified in Clause 29, and small chips that do not adversely affect protection against access to parts requiring protection against simultaneous contact according to B.22.3 are ignored.

If a decorative cover is protected by an inner cover, fracture of the decorative cover is ignored if the inner cover itself withstands the test.

Cracks not visible to the naked eye and surface cracks in fibre-reinforced mouldings and similar materials are ignored.

B.21.1 Separable batteries and **detachable batteries**, when not connected to the appliance, shall have adequate mechanical strength and shall be constructed to withstand such rough handling that may be expected in normal use.

Compliance is checked as follows.

The **fully charged battery**, rigidly supported is subject to test Ehb of IEC 60068-2-75. Three blows, each having an impact energy of 0,5 J, are applied to every point of the **battery** enclosure that is likely to be weak.

If there is doubt as to whether a defect has occurred by the application of test Ehb of IEC 60068-2-75, this defect is neglected and the group of three blows is applied to the same place on a new sample which shall then withstand the test.

Detachable batteries and **separable batteries** shall also be subjected to the test free-fall – procedure 1, of IEC 60068-2-31. They shall be dropped three times from a height of 1 m onto a concrete surface. The **battery** shall be positioned to vary the point of impact. **Batteries** shall be **fully charged** prior to the test.

After the tests, visual inspection shall show there is no damage to the **battery** and the **battery** shall not catch fire, leak fluid that is visible from the outside of the **battery** enclosure or explode and shall meet the requirements of Clause 20, Clause 29, B.22.4 and B.22.5 where short circuit of **functional insulation** will impair compliance with this standard.

Damage to the finish, small dents that do not reduce **clearances** or **creepage distances** below the values specified in Clause 29, and small chips that do not adversely affect protection against access to parts requiring protection against simultaneous contact according to B.22.4 are ignored.

If a decorative cover is protected by an inner cover, fracture of the decorative cover is ignored if the inner cover itself withstands the test.

Cracks not visible to the naked eye and surface cracks in fibre-reinforced mouldings and similar materials are ignored.

For **batteries** that use metal-ion chemistry:

- the open circuit voltage of the **battery** 24 h after the tests shall not be less than 90 % of the voltage measured immediately prior to the tests;
- **cells** shall not have vented by any means other than through their vents.

22 Construction

22.11 Non-detachable parts that protect against electric shock, moisture or contact with moving parts shall be fixed in a reliable manner and withstand the mechanical stress occurring during normal use. Snap-in devices used for fixing such parts shall have an obvious locked position. The fixing properties of snap-in devices used in parts that are likely to be removed during installation or servicing shall be reliable.

22.20 Direct contact between current carrying parts and thermal insulation that would impair compliance with this standard shall be effectively prevented unless such material is non-corrosive, non-hygroscopic and non-combustible.

The requirement is not applicable to glass-wool thermal insulation.

NOTE Non-impregnated slag-wool is an example of corrosive thermal insulation.

22.24 This requirement does not apply to **battery-operated appliances** that do not contain parts requiring protection against simultaneous contact according to B.22.3.

22.25 This requirement does not apply to **battery-operated appliances** that do not contain parts requiring protection against simultaneous contact according to B.22.3.

22.26 This subclause is not applicable.

22.27 This subclause is not applicable.

22.28 This subclause is not applicable.

22.29 This subclause is not applicable.

22.30 This subclause is not applicable.

22.31 This subclause is not applicable.

22.32 This subclause is not applicable.

22.33 Conductive liquids that are or may become accessible in normal use and conductive liquids that are in contact with **accessible metal parts** shall not be in direct contact with current carrying parts or unearthed metal parts that are separated from current carrying parts by **basic insulation** only or with other current carrying parts such that compliance with B.22.3 and B.22.4 would be impaired.

22.34 This subclause is not applicable.

22.35 This subclause is not applicable.

22.36 This subclause is not applicable.

22.37 This subclause is not applicable.

B.22.1 User accessible interfaces between elements of a **battery system** (not mains connections) shall not employ appliance couplers according to IEC 60320 (all parts) or IEC 60309-2.

User accessible interfaces between elements of a **battery system** (not mains connections) shall not employ connectors of the following types unless the **battery system** is adequately protected against the use of an incorrect supply:

- barrel connectors with outside diameters of 6,5 mm or less;
- concentric connectors with a diameter of 3,5 mm or less according to IEC 60603-11.

Compliance is checked by inspection, measurement and for determining adequacy of protection against use of an incorrect supply, by the following test.

The mating connector shall be supplied by a:

- 5 V AC voltage that is increased in 5 V increments to 30 V for 5 min at each increment; and then;
- 10 V DC voltage with less than 10 % ripple in 10 V increments to 60 V for 5 min at each increment.

*The source shall be selected such that its current capability does not limit the charging of the **battery**.*

*During the application of incremental voltages, the appliance shall either be capable of operating normally or, if not, the appliance shall not emit flames, molten metal, or poisonous or ignitable gas in hazardous amounts and temperature rises shall not exceed the values shown in Table 9. No explosion or ignition of the **battery** shall occur during or after the test. **Venting***

of the **cells** is permitted provided that they have not vented by any means other than through their vents.

B.22.2 The external surfaces of **detachable batteries** and **separable batteries** shall be protected against excessive heat from heat sources (directly or via heated discharge air) that would be present during operation of the appliance.

Compliance is checked by inspection during the test of Clause 11.

B.22.3 Battery-operated appliances shall be so constructed and enclosed that there is adequate protection against simultaneous contact with two or more conductive parts where the:

- voltage between them exceeds 42,4 V; and
- current between the conductive parts exceeds 2 mA for DC or 0,7 mA peak for when ripple exceeds 10 %.

Compliance is checked by inspection and the following test.

Test probe B and test probe 18 of IEC 61032 are applied with a force not exceeding 1 N, the appliance being in every possible position except that appliances normally used on the floor and having a mass exceeding 40 kg are not tilted. The test probe is applied through openings to any depth that the probe will permit and is rotated or angled before, during and after insertion to any position. If the opening does not allow the entry of the probe, the force on the probe in the straight position is increased to 20 N when probe B is used or 10 N when probe 18 is used. If the probe then enters the opening, the test is repeated with the probe in the angled position.

*During the tests with test probe B, all **detachable parts** are removed except lamps located behind a **detachable cover** are not removed. However, during insertion or removal of lamps which are located behind a **detachable cover**, protection against simultaneous contact with parts having a voltage between them exceeding 42,4 V shall be ensured.*

During the tests with test probe 18, the appliance shall be fully assembled as in normal use without any parts removed.

However, test probe 18 is not applied to appliances for commercial use unless they are intended to be installed in an area open to the public.

It shall not be possible to touch two or more conductive parts of opposite polarity with the probes if the voltage between them exceeds 42,4 V and the current between them exceeds 2 mA for DC or 0,7 mA peak for when ripple exceeds 10 %.

The current is measured using the circuit in Figure 4 of IEC 60990:2016.

B.22.4 Separable batteries and detachable batteries shall be so constructed and enclosed that there is adequate protection against simultaneous contact with two or more conductive parts where the:

- voltage between them exceeds 42,4 V; and
- current between the conductive parts exceeds 2 mA.

Compliance is checked by inspection and the following test.

*Test probe B and test probe 18 of IEC 61032 are applied with a force not exceeding 1 N, the **battery** being in every possible position except that **batteries** having a mass exceeding 40 kg are not tilted. The test probe is applied through openings to any depth that the probe will permit and is rotated or angled before, during and after insertion to any position. If the opening does not allow the entry of the probe, the force on the probe in the straight position is increased to*

20 N. If the probe then enters the opening, the test is repeated with the probe in the angled position.

During the tests with:

- test probe B, all **detachable parts** are removed;
- test probe 18, no parts are removed.

However, test probe 18 is not applied to **batteries** for appliances for commercial use unless they are intended to be installed in an area open to the public.

It shall not be possible to touch two or more conductive parts of opposite polarity with the probes if the voltage between them exceeds 42,4 V and the current between them exceeds 2 mA.

The current is measured using the circuit in Figure 4 of IEC 60990:2016.

B.22.5 Insulating materials providing protection against simultaneous contact with two or more conductive parts shall be adequate when:

- they are within 1,0 mm of the conductive parts;
- the voltage between the conductive parts exceeds 42,4 V peak; and
- the current between the conductive parts exceeds 2 mA for DC or 0,7 mA peak for when ripple exceeds 10 %.

Compliance is checked by inspection, measurement and the following test.

The insulating material is subjected for 60 s to 750 V or 1,2 times the **working voltage** plus 700 V, whichever is greater, in accordance with IEC 61180. The test voltage is applied on opposing sides of the insulating material.

NOTE This does not exclude the testing of the material as situated within the appliance.

During the test care shall be taken to avoid overstressing parts not needed to provide protection against simultaneous contact with two or more conductive parts.

The high-voltage source used for the test is to be capable of supplying a short circuit current I_s between the output terminals after the output voltage has been adjusted to the appropriate test voltage. The overload release of the circuit is not to be operated by any current below the tripping current I_r . The values of I_s and I_r are 200 mA and 100 mA, respectively.

No breakdown shall occur during the test.

Glow discharges without a drop in voltage are neglected.

The current is measured using the circuit in Figure 4 of IEC 60990:2016.

B.22.6 Vents of **cells** shall not be obstructed in such a way as to defeat their operation if **venting** is relied upon for compliance with this standard.

Compliance is checked by inspection and by the tests of this standard.

23 Internal wiring

23.3 Instead of the electric strength test of 16.3, **battery-operated appliances** shall comply with B.22.3.

23.5 For **battery-operated appliances** compliance is checked by the test of B.22.5.

24 Components

24.1 Batteries are not required to comply with IEC 62133-1:2017 or IEC 62133-2:2017. They are tested as part of the appliance according to this standard.

24.1.1 This subclause is not applicable.

24.1.3 Switches in **battery-operated appliances** shall have adequate breaking capacity and shall withstand, without excessive wear or other harmful effect, the mechanical, electrical, and thermal stresses occurring in the **battery-operated appliance**.

The relevant standard for switches is IEC 61058-1-1:2016 for mechanical switches and IEC 61058-1-2:2016 for electronic switches. The number of cycles declared for 7.4 of IEC 61058-1:2016 shall be at least 10 000 under the load conditions encountered in the appliance, this being the declared specific load according to 7.2.5 of IEC 61058-1:2016. If the switch makes and breaks a locked rotor current, the number of cycles declared for 7.4.9 of IEC 61058-1:2016 shall be at least 50 under the load conditions encountered in the appliance, this being the declared specific load according to 7.2.5 of IEC 61058-1:2016.

The declared number of operating cycles is only applicable for switches required for compliance with this standard.

Unless switches have been previously tested to and found to comply with IEC 61058-1-1:2016 or IEC 61058-1-2:2016 for the number of cycles declared, compliance is checked by the following tests conducted on separate samples:

- 50 cycles of making and breaking the locked motor current, if any, encountered in the **battery-operated appliance** incorporating a **battery** that is **fully charged**. Each "on" period having a duration of not more than 0,5 s and each "off" period having a duration of at least 10 s;
- 10 000 cycles of making and breaking the current encountered in a **battery-operated appliance** incorporating a **battery** that is **fully charged** with no additional mechanical load. The switch is actuated at a uniform rate of 30 cycles per minute.

The switch shall complete the required cycles of operation and shall have no electrical or mechanical failure. At the end of the tests:

- the switch contacts shall operate properly in the "on" and "off" positions;
- the temperature rise of the switch terminals shall not have increased by more than 30 K above the temperature rise measured in Clause 11.

B.24.1 The relevant standards for non-acid based electrolyte **cells** employed in **batteries** are IEC 62133-1:2017 for nickel systems and IEC 62133-2:2017 for lithium systems.

NOTE The requirement for **cells** does not extend to the **battery** itself.

A **battery** that uses metal-ion chemistry shall additionally be subjected to the tests of Subclauses 7.3.8.1 (vibration) and 7.3.8.2 (mechanical shock) of IEC 62133-2:2017.

25 Supply connection and external flexible cords

25.9 The requirement also applies to **interconnection cords** of **battery-operated appliances**.

25.14 The requirement also applies to **interconnection cords** of **battery-operated appliances**.

25.15 The requirement also applies to **interconnection cords** of **battery-operated appliances**.

B.25.1 Insulated conductors of **interconnection cords** of **battery-operated appliances** shall comply with the requirements for internal wiring and shall be provided with at least 0,5 mm thick outer sheath made of insulating material equivalent to that of **supply cords** described in 25.7.

Compliance is checked by inspection and by test.

26 Terminals for external conductors

B.26.1 Terminal devices in an appliance for the connection of the flexible leads or flexible cord connecting a **separable battery** shall be so located or shielded that there is no risk of incorrect connection.

Compliance is checked by inspection.

27 Provision for earthing

27.1 The **battery-operated appliance** shall have no provision for a protective earth but may incorporate a functional earth.

29 Clearances, creepage distances and solid insulation

29.1 Clearances shall not be less than the values specified in Table 16, taking into account the **rated impulse voltage**. For **battery-operated appliances**, the **rated impulse voltage** shall be 500 V for **working voltages** less than 50 V and 1 500 V for all other **working voltages**. However, if the construction, including between parts of opposite polarity for connecting the **battery**, is such that the distances could be affected by wear, by distortion, by movement of the parts or during assembly, the **clearances** for **rated impulse voltages** of 1 500 V are increased by 0,5 mm and the impulse voltage test is not applicable.

NOTE The procedure for assessing **clearances** is given in informative Annex L.

B.29.1.1 For parts requiring protection against simultaneous contact according to B.22.3 and B.22.4, the sum total of the **clearances** between each of these parts and their nearest accessible surface shall not be less than two times the Table 16 **clearance** taking into account the **rated impulse voltage**. For the purpose of this determination, at least one of the **clearances** shall be not less than 1,0 mm.

Compliance is checked by measurement.

NOTE The procedure for assessing **clearances** is given in Clause L.3.

B.29.2.1 For parts requiring protection against simultaneous contact according to B.22.3 and B.22.4, the sum total of the **creepage distances** between each of these parts and their nearest accessible surface shall not be less than two times the Table 17 **creepage distances**. For the purpose of this determination, at least one of the **creepage distances** shall be not less than 1,0 mm.

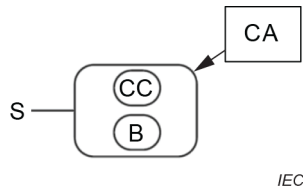
Compliance is checked by measurement.

NOTE The procedure for assessing **creepage distances** is given in Clause L.2.

30 Resistance to heat and fire

30.1 External parts of non-metallic material, the deterioration of which might cause the **battery-operated appliance**, **separable battery** or **detachable battery** to fail to comply with this annex, shall be sufficiently resistant to heat.

a)

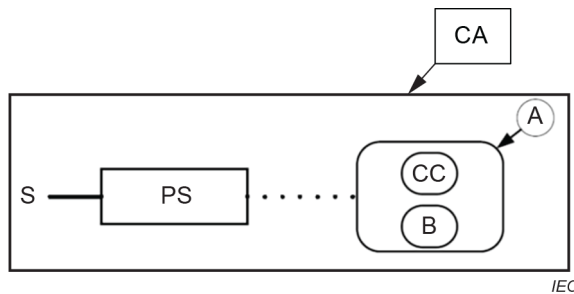


Complete appliance:

Tested to main part of standard while operated or charged by mains or renewable energy source (otherwise not applicable)

Tested to normative Annex B when operated on **battery** power

b)



Detachable power supply part:

Tested to main part of standard with and without the appliance connected

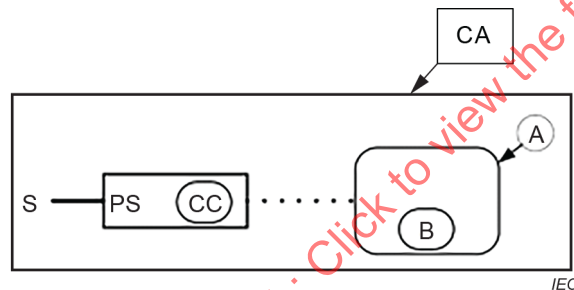
Complete appliance:

Tested to main part of standard while operated by or charged by mains or renewable energy source

Appliance functional part:

Tested to normative Annex B when operated on **battery** power

c)



Detachable power supply part:

Tested to main part of standard with and without the appliance connected

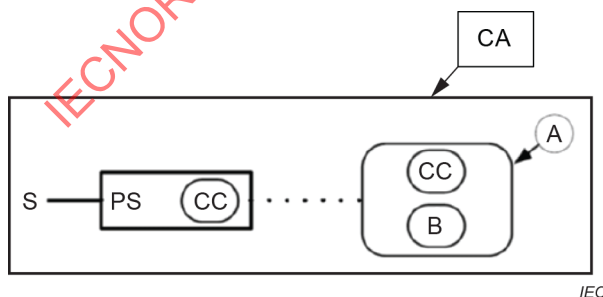
Complete appliance:

Tested to main part of standard while operated by or charged by mains or renewable energy source

Appliance functional part:

Tested to normative Annex B when operated on **battery** power

d)



Detachable power supply part:

Tested to main part of standard with and without the appliance connected

Complete appliance:

Tested to main part of standard while operated by or charged by mains or renewable energy source

Appliance functional part:

Tested to normative Annex B when operated on **battery** power

Figure B.1 – Examples of battery-operated appliance constructions and application of normative Annex B (1 of 2)

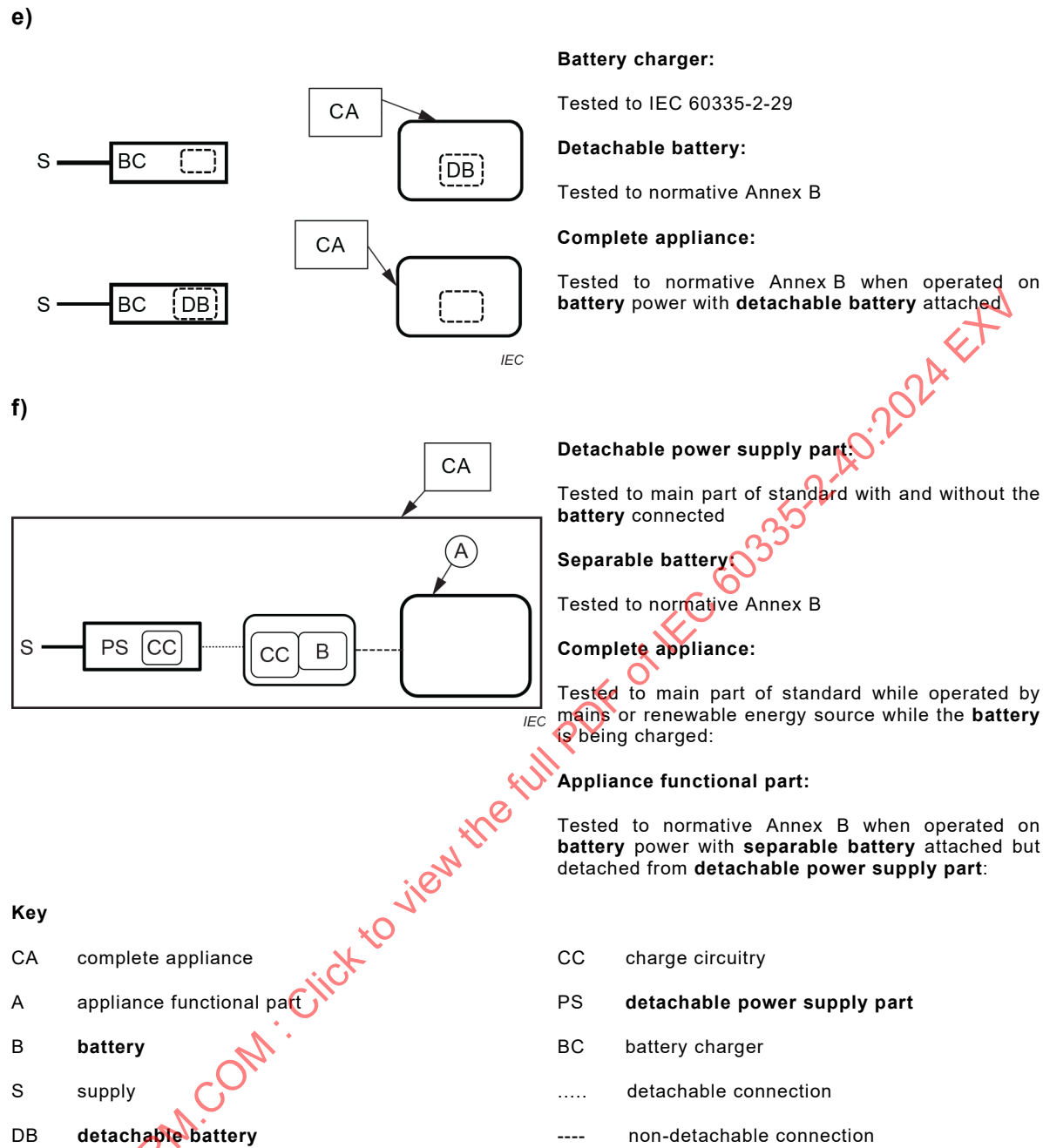
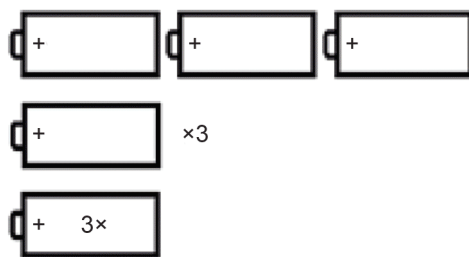


Figure B.1 (2 of 2)



IEC

Figure B.2 – Examples of correct polarity connection marking representing three batteries

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex C (normative)

Ageing test on motors

This annex is applicable when there is doubt with regard to the temperature classification of the insulation of a motor winding, for example:

- if the temperature rise of the motor winding exceeds the values specified in Table 3;
- when well-known insulating materials are used in an unconventional way;
- when combinations of materials of different temperature classes are used at a temperature higher than that allowed for the lowest class;
- when materials are used for which sufficient experience is not available, for instance in motors having integral core insulation.

This test is carried out on six samples of the motor.

The rotor of each motor is locked and a current is passed individually through the rotor winding and the stator winding, this current being such that the temperature of the relevant winding is equal to the maximum temperature rise measured during the test of Clause 11, increased by 25 K. This temperature is further increased by one of the values chosen from Table C.1. The corresponding total time during which the current is passed is indicated in the table.

Table C.1 – Test conditions

Temperature increase K	Total time h
0 ± 3	p^a
10 ± 3	$0,5 p$
20 ± 3	$0,25 p$
30 ± 3	$0,125 p$
NOTE The temperature increase chosen is selected by the manufacturer.	
^a p is 8 000 unless otherwise specified in the relevant part 2.	

The total time is divided into four equal periods, each being followed by a period of 48 h during which the motor is subjected to the humidity test of 15.3. After the final humidity test, the insulation shall withstand the electric strength test of 16.3, but with the test voltage reduced to 50 % of the value specified.

After each of the four periods and before the subsequent humidity test, the leakage current of the insulating system is measured as specified in 13.2, any component not forming part of the insulation system under test being disconnected before the measurement is made.

The leakage current shall not exceed 0,5 mA.

Failure of only one of the six motors during the first of the four periods of the test is ignored.

If one of the six motors fails during the second, third or fourth period of the test, the remaining five motors are subjected to a fifth period followed by the humidity test and the electric strength test.

The remaining five motors shall complete the test.

Annex D
(normative)

Thermal motor protectors

This annex of Part 1 is not applicable.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex E (normative)

Needle-flame test

The needle-flame test is carried out in accordance with IEC 60695-11-5:2016 with some of the clauses of IEC 60695-11-5:2016 being modified as follows.

7 Flame application times

Replacement:

The duration of application of the test flame is $30\text{ s} \pm 1\text{ s}$.

9 Test procedure

9.2 Position of test specimen

Modification:

The specimen is arranged so that the flame can be applied to a vertical or horizontal edge as shown in the examples of Figure 2.

9.3 Application of needle-flame

Modification:

The first paragraph does not apply.

Addition:

If possible, the flame is applied at least 10 mm from a corner.

9.4 Number of test specimens

Replacement:

The test is carried out on one specimen. If the specimen does not withstand the test, the test may be repeated on two additional specimens, both of which shall then withstand the test.

11 Evaluation of test results

Addition:

The duration of burning (t_b) shall not exceed 30 s. However, for printed circuit boards, the duration of burning shall not exceed 15 s.

Annex F (normative)

Capacitors

Capacitors likely to be permanently subjected to the supply voltage, and used for radio interference suppression or for voltage dividing, shall comply with the following clauses of IEC 60384-14:2013 including IEC 60384-14:2013/AMD1:2016, being modified as follows.

1.5 Terms and definitions

1.5.3 This subclause is applicable.

Class X capacitors are tested according to subclass X2.

1.5.4 This subclause is applicable.

Class Y capacitors are tested according to subclass Y2.

1.6 Marking

Items a) and b) of this subclause are applicable.

3.4 Approval testing

3.4.3.2 Tests

Table 3 is applicable as follows:

- group 0: Subclauses 4.1, 4.2.1 and 4.2.5;
- group 1A: Subclause 4.1.1;
- group 2: Subclause 4.12;
- group 3: Subclauses 4.13 and 4.14;
- group 6: Subclause 4.17;
- group 7: Subclause 4.18.

4.1 Visual examination and check of dimensions

This subclause is applicable.

4.2 Electrical tests

4.2.1 This subclause is applicable.

4.2.5 This subclause is applicable.

4.2.5.2 Only Table 11 is applicable. The values for test A apply; however, for capacitors in **heating appliances**, the values for test B or test C apply.

4.12 Damp heat, steady state

This subclause is applicable.

Only insulation resistance and voltage proof are checked (see Table 15).

4.13 Impulse voltage

This subclause is applicable.

4.14 Endurance

Subclauses 4.14.1, 4.14.3, 4.14.4 and 4.14.7 are applicable.

4.14.7 Only insulation resistance and voltage proof are checked (see Table 16) together with a visual examination to ensure that there is no visible damage.

4.17 Passive flammability test

This subclause is applicable.

4.18 Active flammability test

This subclause is applicable.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex G (normative)

Safety isolating transformers

The following modifications to this standard are applicable for **safety isolating transformers**.

The clause numbers in this Annex refer to the clause numbers in the main part of this standard that are modified.

7 Marking and instructions

7.1 Transformers for specific use shall be marked with the:

- name, trademark or identification mark of the manufacturer or responsible vendor;
- model or type reference.

NOTE The definition of transformers for specific use is given in IEC 61558-1:2017.

17 Overload protection of transformers and associated circuits

Fail-safe transformers shall comply with Subclause 15.5 of IEC 61558-1:2017.

NOTE This test is carried out on three transformers.

22 Construction

Subclauses 19.1 and 19.1.2 of IEC 61558-2-6:2009 are applicable.

29 Clearances, creepage distances and solid insulation

29.1, 29.2 and 29.3 The distances specified in Table 20, Table 21 and Table 22 of IEC 61558-1:2017 apply.

For insulated winding wires complying with Subclause 19.12.3 of IEC 61558-1:2017 there are no requirements for **clearances** or **creepage distances**. In addition, for windings providing **reinforced insulation**, the distances specified in Table 20 and Table 21 of IEC 61558-1:2017 are not assessed.

For **safety isolating transformers** subjected to periodic voltages with a frequency exceeding 30 kHz, the **clearances**, **creepage distances** and **solid insulation** values specified in IEC 60664-4:2005 are applicable, if these values are greater than the values specified in Table 20, Table 21 and Table 22 of IEC 61558-1:2017.

Annex H (normative)

Switches

Switches shall comply with the following clauses of IEC 61058-1:2016 and IEC 61058-1-1:2016, as appropriate, being modified as follows.

The tests are carried out under the conditions occurring in the appliance.

Before being tested, switches are operated 20 times without load.

8 Marking and documentation

Switches are not required to be marked. However, a switch that can be tested separately from the appliance shall be marked with the manufacturer's name or trademark and the type reference.

13 Mechanism

NOTE The tests can be carried out on a separate sample.

15 Insulation resistance and dielectric strength

Subclause 15.1 is not applicable.

Subclause 15.2 is not applicable.

Subclause 15.3 is applicable for full disconnection and micro-disconnection. This test is carried out immediately after the humidity test of Subclause 15.3 of IEC 60335-1.

17 Endurance

Compliance is checked on three separate appliances or switches.

For 17.5.4 of IEC 61058-1-1:2016, the number of cycles of actuation declared according to 7.4 is 10 000 unless otherwise specified in Subclause 24.1.3 of IEC 60335-1.

Switches intended for operation under no load and which can be operated only with the aid of a tool are not subjected to the tests. This applies also for such switches operated by hand that are interlocked so that they cannot be operated under load. However, switches without this interlock are subjected to the test of 17.5.4 of IEC 61058-1-1:2016 for 100 cycles of operation.

Subclauses 17.3 and 17.6.2 of IEC 61058-1-1:2016 are not applicable. The ambient temperature during the test is that occurring in the appliance during the test of Clause 11 in IEC 60335-1, as specified in footnote b of Table 3.

At the end of the tests, the temperature rise of the terminals shall not have increased by more than 30 K above the temperature rise measured in Clause 11 of IEC 60335-1.

20 Clearances, creepage distances, solid insulation and coatings of rigid printed board assemblies

Clause 20 of IEC 61058-1:2016 is applicable to **clearances** across full disconnection and micro-disconnection. It is also applicable to **creepage distances** for **functional insulation**, across full disconnection and micro-disconnection, as stated in Table 14.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex I
(normative)

**Motors having basic insulation that is inadequate
for the rated voltage of the appliance**

This annex of Part 1 is not applicable.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex J (normative)

Coated printed circuit boards

Protective coatings of printed circuit boards shall comply with IEC 60664-3:2016 with some of the clauses of IEC 60664-3:2016 being modified as follows.

5 Tests

5.1 General

When production samples are used, three samples of the printed circuit board are tested.

5.7 Conditioning of the test specimens

5.7.2 Cold conditioning

The test is carried out at –25 °C.

5.7.4 Rapid change of temperature

Severity 1 is specified, the number of cycles is 5.

5.7.5.2 Additional conditioning with respect to electromigration

The test duration is 10 days.

5.9 Additional tests

This subclause is not applicable.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex K (informative)

Overvoltage categories

The following information on overvoltage categories is extracted from IEC 60664-1:2007.

Overvoltage category is a numeral defining a transient overvoltage condition.

Equipment of overvoltage category IV is for use at the origin of the installation.

NOTE 1 Examples of such equipment are electricity meters and primary overcurrent protection equipment.

Equipment of overvoltage category III is equipment in fixed installations and for cases where the reliability and the availability of the equipment is subject to special requirements.

NOTE 2 Examples of such equipment are switches in the fixed installation and equipment for industrial use with permanent connection to the fixed installation.

Equipment of overvoltage category II is energy consuming equipment to be supplied from the fixed installation.

NOTE 3 Examples of such equipment are appliances, portable tools and other household and similar loads.

If such equipment is subjected to special requirements with regard to reliability and availability, overvoltage category III applies.

Equipment of overvoltage category I is equipment for connection to circuits in which measures are taken to limit transient overvoltages to an appropriately low level.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex L (informative)

Guidance for the measurement of clearances and creepage distances

L.1 When measuring **clearances**, the following applies.

The **rated voltage** and overvoltage category are determined (see informative Annex K).

NOTE 1 In general, appliances are in overvoltage category II.

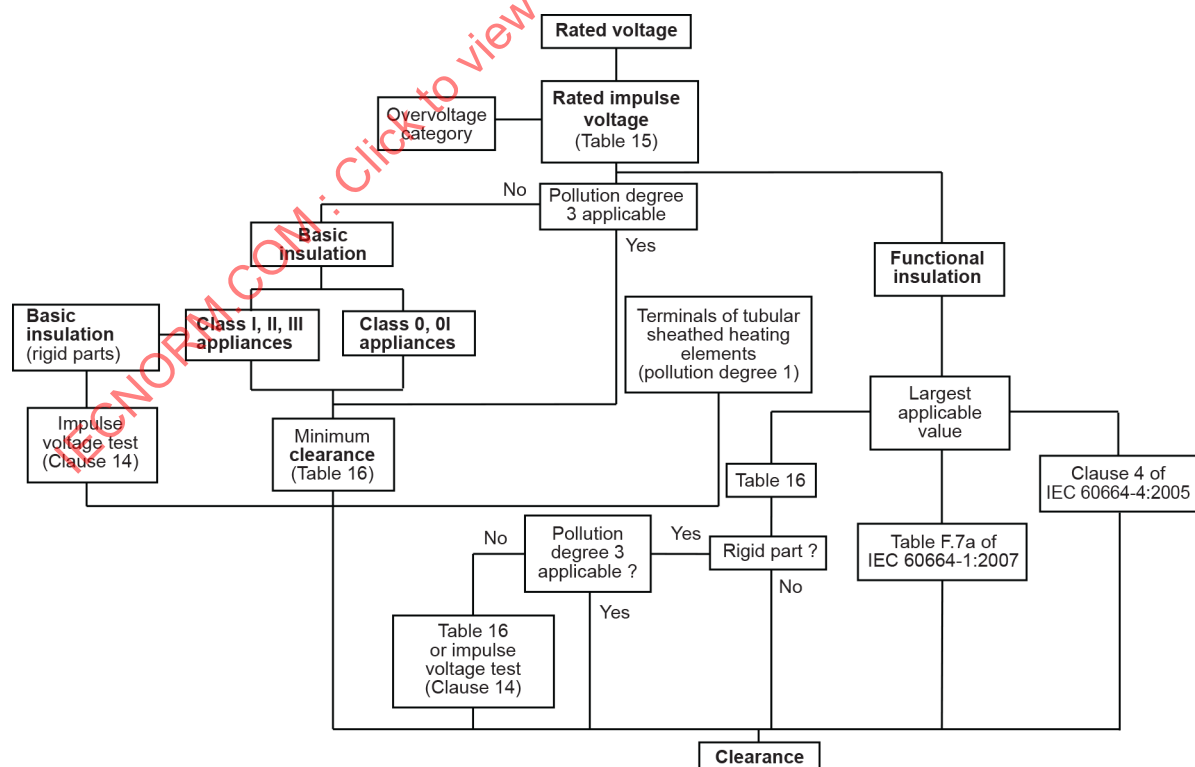
The **rated impulse voltage** is determined from Table 15.

If pollution degree 3 is applicable, or if the appliance is **class 0** or **class 01**, the **clearances** for **basic insulation** and **functional insulation** are measured and compared with the values specified in Table 16. For other cases, the impulse voltage test may be carried out if the rigidity requirements of 29.1 are met, otherwise the values specified in Table 16 apply. However, for **functional insulation** that is subjected to a steady-state voltage or recurring peak voltage with a frequency not exceeding 30 kHz, the **clearances** are also obtained from Table F.7a in IEC 60664-1:2007 or if the frequency exceeds 30 kHz, Clause 4 in IEC 60664-4:2005. The larger of the values so obtained is applied if they exceed the values specified in Table 16.

Clearances of **supplementary insulation** and **reinforced insulation** are measured and compared with the values specified in Table 16.

NOTE 2 Special considerations apply for **clearances** subjected to higher **working voltages** than **rated voltage**. For these requirements, refer to the text in 29.1.5.

NOTE 3 The sequence for determining **clearances** is shown in Figure L.1.



IEC

Figure L.1 – Sequence for the determination of clearances

L.2 When measuring **creepage distances**, the following applies.

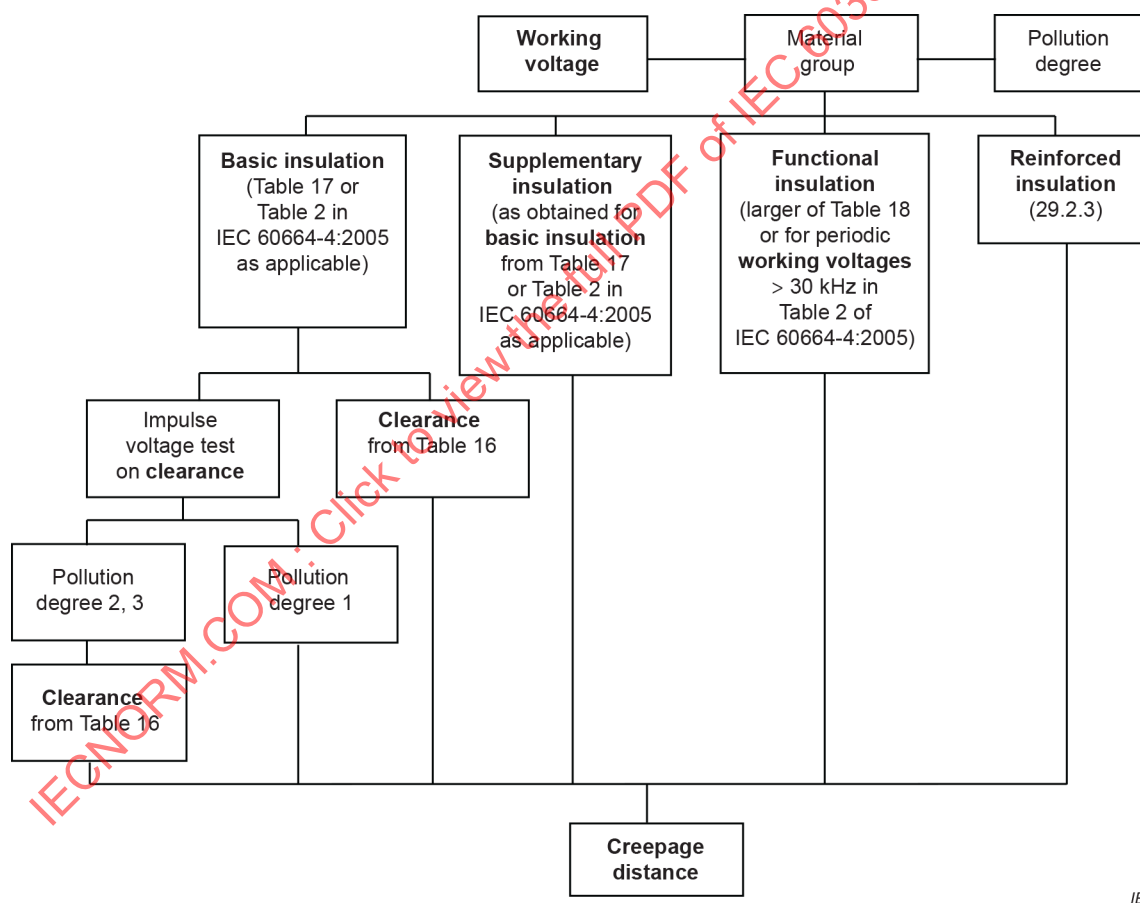
The **working voltage**, pollution degree and material group are determined.

The **creepage distances** of **basic insulation** and **supplementary insulation** are measured and compared with the values specified in Table 17 or Table 2 in IEC 60664-4:2005 as appropriate. A particular **creepage distance** is then compared with the corresponding **clearance** of Table 16 and enlarged if necessary in order not to be less than the **clearance**. For pollution degree 1, the reduced **clearance** based on the impulse voltage test can be used. However, the **creepage distance** cannot be less than the values of Table 17.

The **creepage distances** of **functional insulation** are measured and compared with the values specified in Table 18 or, for periodic **working voltages** exceeding 30 kHz, Table 2 of IEC 60664-4:2005.

The **creepage distances** of **reinforced insulation** are measured and compared with twice the values specified in Table 17.

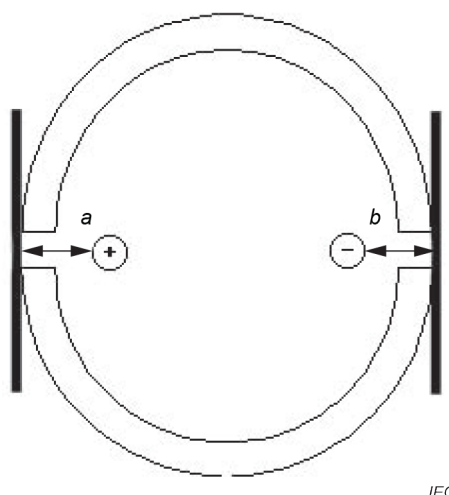
NOTE The sequence for determining **creepage distances** is shown in Figure L.2



IEC

Figure L.2 – Sequence for the determination of creepage distances

L.3 When measuring the sum total of distances between parts requiring protection against simultaneous contact according to B.29.1.1 and **accessible surfaces**, the distance from each part to the **accessible surface** shall be added together to determine the sum total. See Figure L.3.



IEC

Key

- Dimension *a* positive bare part distance to the external surface represented by foil stretched across the openings
 Dimension *b* negative bare part distance to the external surface represented by foil stretched across the openings
a + b sum total as specified in B.29.1.1.

Figure L.3 – Measurement of clearances

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex M (informative)

Pollution degree

The following information on pollution degrees is extracted from IEC 60664-1:2007.

- Pollution

The microenvironment determines the effect of pollution on the insulation. The macro-environment, however, has to be taken into account when considering the microenvironment.

Means may be provided to reduce pollution at the insulation under consideration by effective use of enclosures, encapsulation or hermetic sealing. Such means to reduce pollution may not be effective when the equipment is subjected to condensation or if, in normal use, it generates pollutants itself.

Small **clearances** can be bridged completely by solid particles, dust and water and therefore minimum **clearances** are specified where pollution may be present in the microenvironment.

NOTE 1 Pollution will become conductive in the presence of humidity. Pollution caused by contaminated water, soot, metal or carbon dust is inherently conductive.

NOTE 2 Conductive pollution by ionized gases and metallic depositions occur only in specific instances, for example in arc chambers of switchgear or controlgear and is not covered by IEC 60664-1:2007.

- Degrees of pollution in the microenvironment

For the purpose of evaluating **creepage distances**, the following four degrees of pollution in the microenvironment are established:

- pollution degree 1: no pollution or only dry, non-conductive pollution occurs. The pollution has no influence;
- pollution degree 2: only non-conductive pollution occurs, except that occasionally a temporary conductivity caused by condensation is to be expected;
- pollution degree 3: conductive pollution occurs or dry non-conductive pollution occurs that becomes conductive due to condensation that is to be expected;
- pollution degree 4: the pollution generates persistent conductivity caused by conductive dust or by rain or snow.

NOTE 3 Pollution degree 4 is not applicable to appliances.

Annex N (normative)

Proof tracking test

The proof tracking test is carried out in accordance with IEC 60112:2003 including IEC 60112:2003/AMD1:2009 with some of the clauses of IEC 60112:2003 including IEC 60112:2003/AMD1:2009 being modified as follows.

7 Test apparatus

7.3 Test solutions

Test solution A is used.

10 Determination of proof tracking index (PTI)

10.1 Procedure

Modification:

The proof voltage is 100 V, 175 V, 250 V, 400 V or 600 V as appropriate.

The test is carried out on five specimens.

In case of doubt, a material is considered to have a PTI of the specified value if it withstands the test at a voltage equal to the proof voltage reduced by 25 V, the number of drops being increased to 100.

10.2 Report

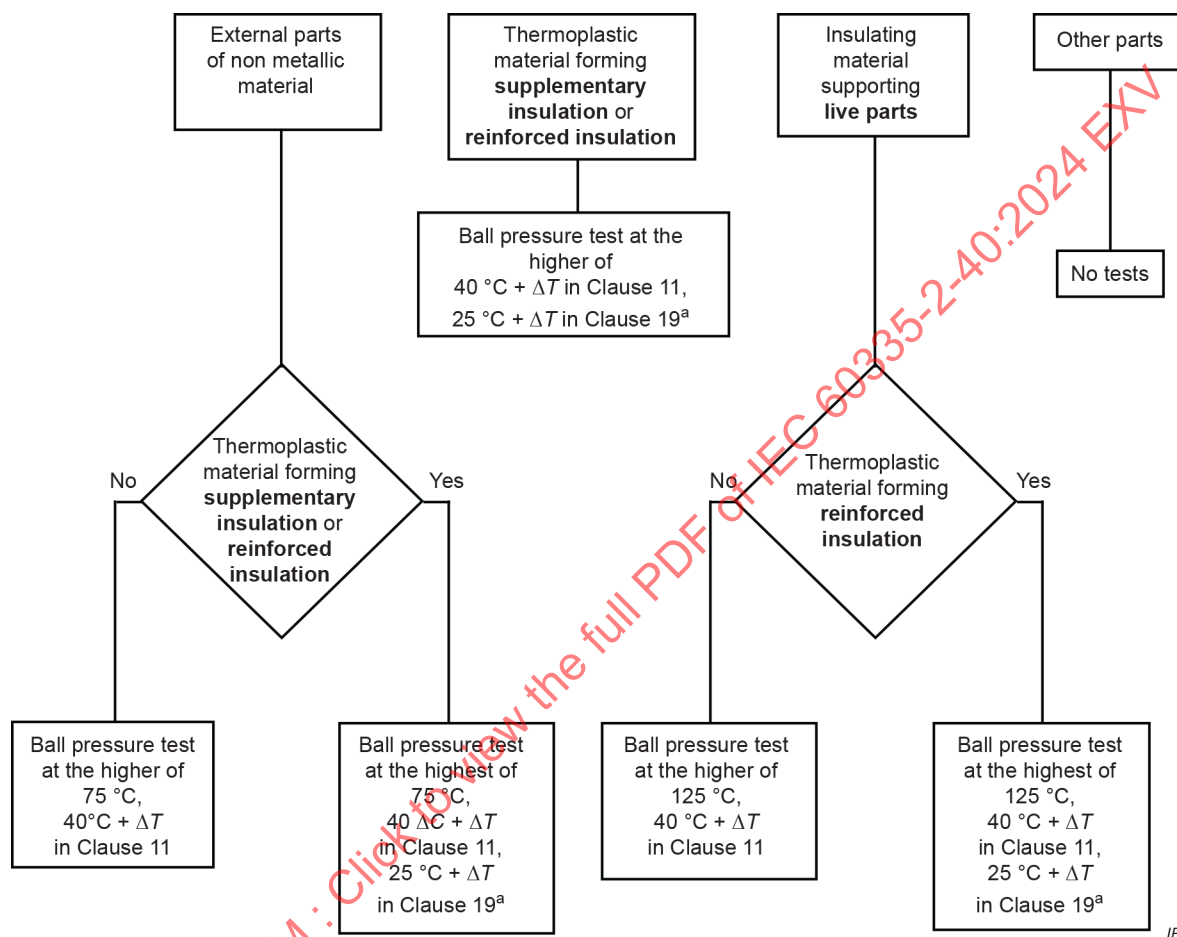
Addition:

The report shall state if the PTI value was based on a test using 100 drops with a test voltage of (PTI-25) V.

Annex O (informative)

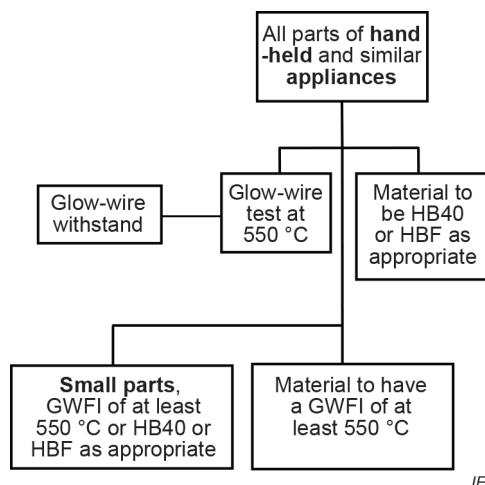
Selection and sequence of the tests of Clause 30

For correct application of this standard, the normative text takes precedence over the guidance given in this annex and reliance should not to be placed on these figures.



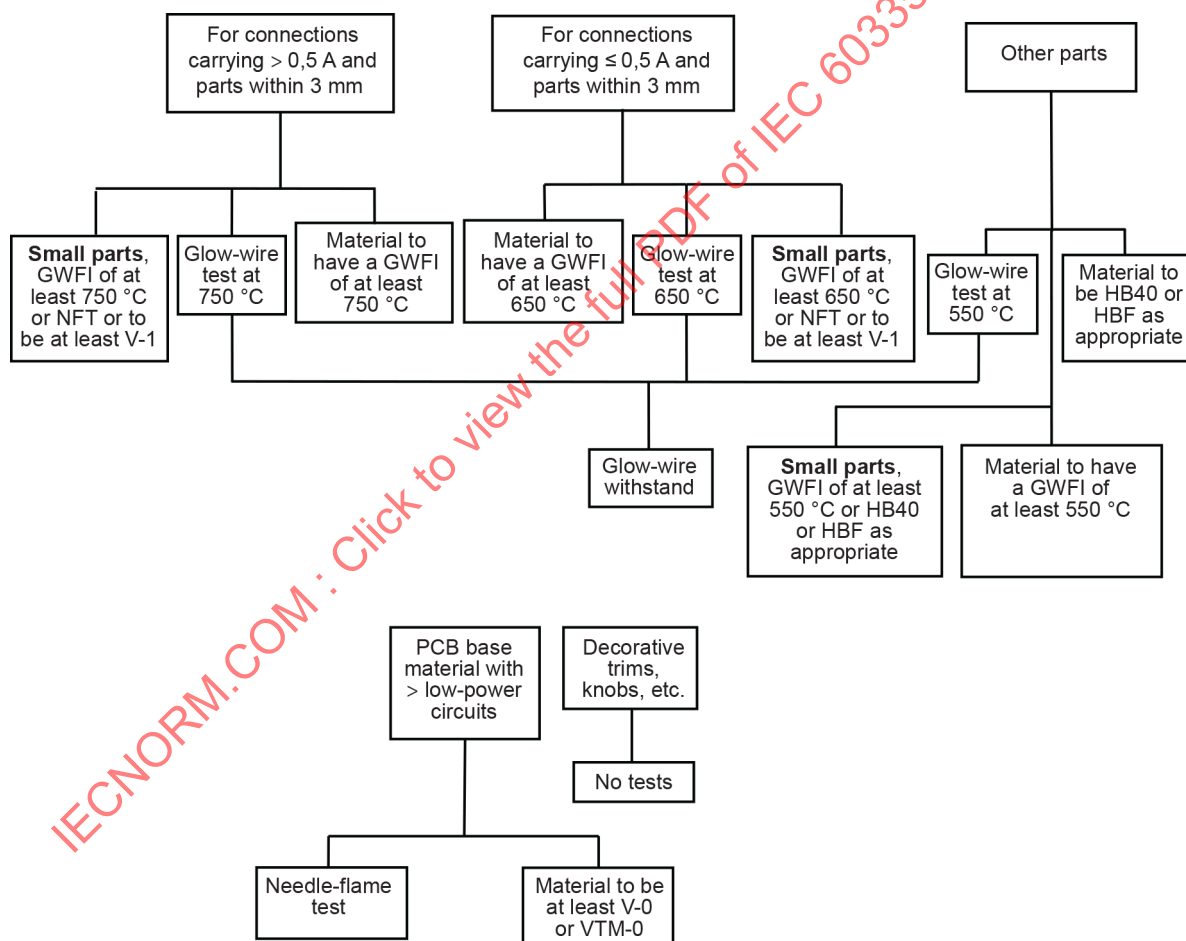
^a ΔT is not taken into account if the tests of 19.4 and 19.5 are terminated by the operation of a **non-self-resetting protective device** requiring the use of a **tool** or removal of a cover to reset it.

Figure O.1 – Tests for resistance to heat



IEC

Figure O.2 – Selection and sequence of tests for resistance to fire in hand-held appliances



IEC

Figure O.3 – Selection and sequence of tests for resistance to fire in attended appliances

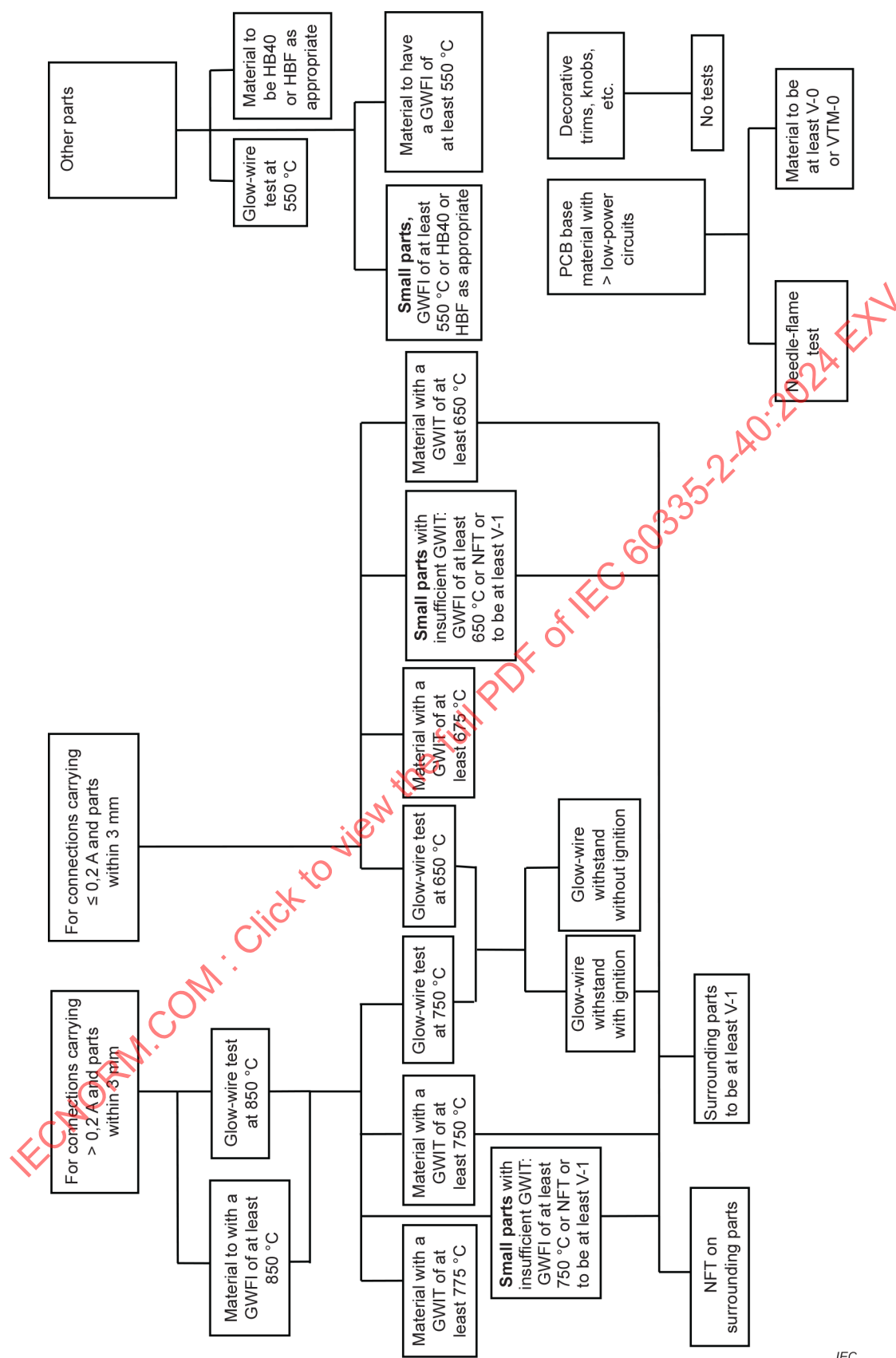
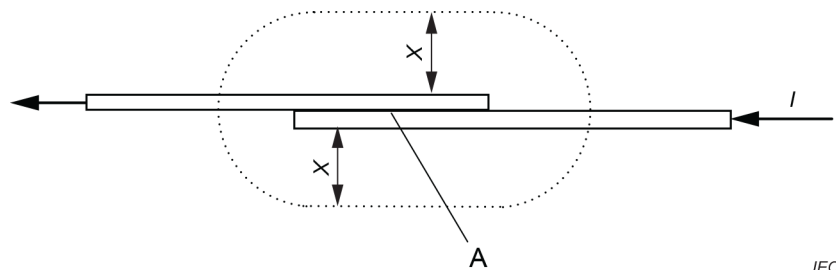
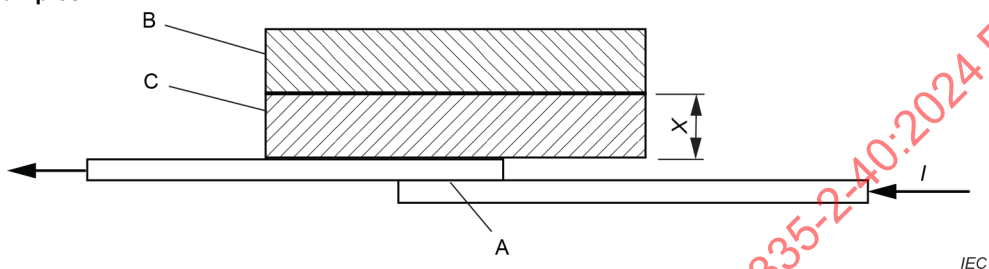


Figure O.4 – Selection and sequence of tests for resistance to fire in unattended appliances

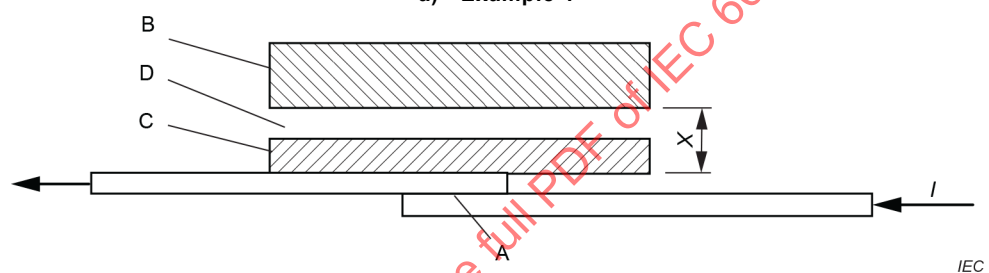


"Within a distance of 3 mm" means falling within the dotted boundary formed by the cylinder with hemispherical ends, as shown in the above drawing.

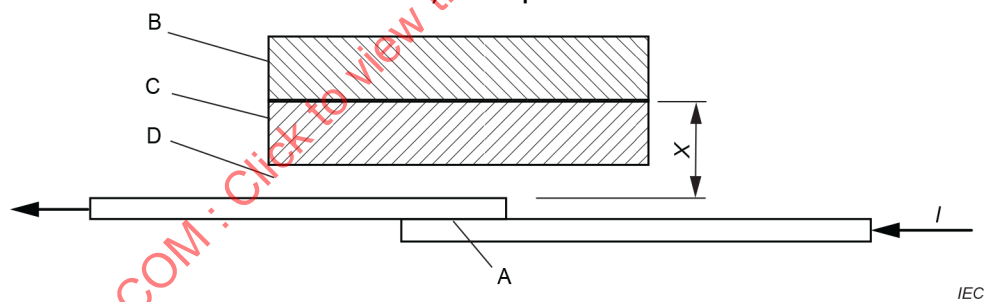
Some examples:



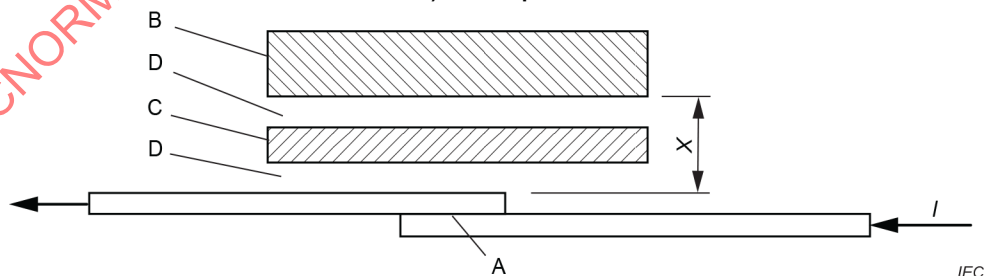
a) Example 1



b) Example 2



c) Example 3



d) Example 4

Key

A connection zone

B non-metallic material

C non-metallic material

D air gap

I current greater than 0,5 A in attended appliances and greater than 0, 2 A in unattended appliances

X distance from the connection

NOTE The distance X is not measured from the point of the connection since there is little or no temperature gradient across the current-carrying conductors.

Explanation

Example	$X \leq 3 \text{ mm}$		$X > 3 \text{ mm}$	
	Material subjected to glow-wire test		Material subjected to glow-wire test	
	B	C	B	C
1	Yes	Yes	No	Yes
2	Yes	Yes	No	Yes
3	Yes	Yes	No	Yes
4	Yes	Yes	No	Yes

Consequential test

In unattended appliances, B is also subjected to the needle-flame if C produces a flame that persists for longer than 2 s during the glow-wire test of 30.2.3.2.

Figure O.5 – Some applications of the term "within a distance of 3 mm"

Annex P (informative)

Guidance for the application of this standard to appliances used in tropical climates

The following modifications to this standard are applicable for **class 0 appliances** and **class 0I appliances** having a **rated voltage** exceeding 150 V, that are intended to be used in countries having a tropical climate and that are marked with symbol IEC 60417-6332 (2015-06).

NOTE Tropical climates are characterized by high humidity and high ambient temperatures with little variation, as specified in IEC 60721-2-1.

They may also be applied to **class I appliances** having a **rated voltage** exceeding 150 V that are intended to be used in countries having a tropical climate and that are marked with symbol IEC 60417-6332 (2015-06), if they are liable to be connected to a supply mains that excludes the protective earthing conductor due to deficiencies in the fixed wiring system.

The clause numbers in this Annex refer to the clause numbers in the main part of this standard that are modified.

5 General conditions for the tests

5.7 The ambient temperature for the tests of Clauses 11 and 13 is 40^{+3}_{0} °C.

7 Marking and instructions

7.1 The appliance shall be marked with symbol IEC 60417-6332 (2015-06).

7.6



[symbol IEC 60417-6332
(2015-06)]

tropical climate

7.12 The instructions shall state that the appliance is to be supplied through a residual current device (RCD) having a rated residual operating current not exceeding 30 mA.

The instructions shall state the substance of the following:

This appliance is considered to be suitable for use in countries having a tropical climate.
It may also be used in other countries.

If symbol IEC 60417-6332 (2015-06) is used, its meaning shall be explained.

11 Heating

11.8 The values of Table 3 are reduced by 15 K.

13 Leakage current and electric strength at operating temperature

13.2 The leakage current for **class I appliances** shall not exceed 0,5 mA.

15 Moisture resistance

15.3 *The value of t is 37 °C.*

16 Leakage current and electric strength

16.2 *The leakage current for **class I appliances** shall not exceed 0,5 mA.*

19 Abnormal operation

19.13 *The leakage current test of 16.2 is applied in addition to the electric strength test of 16.3.*

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex Q (informative)

Sequence of tests for the evaluation of electronic circuits

For correct application of this standard, the normative text takes precedence over the guidance given in this annex and reliance should not be placed on the flow chart of Figure Q.1.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

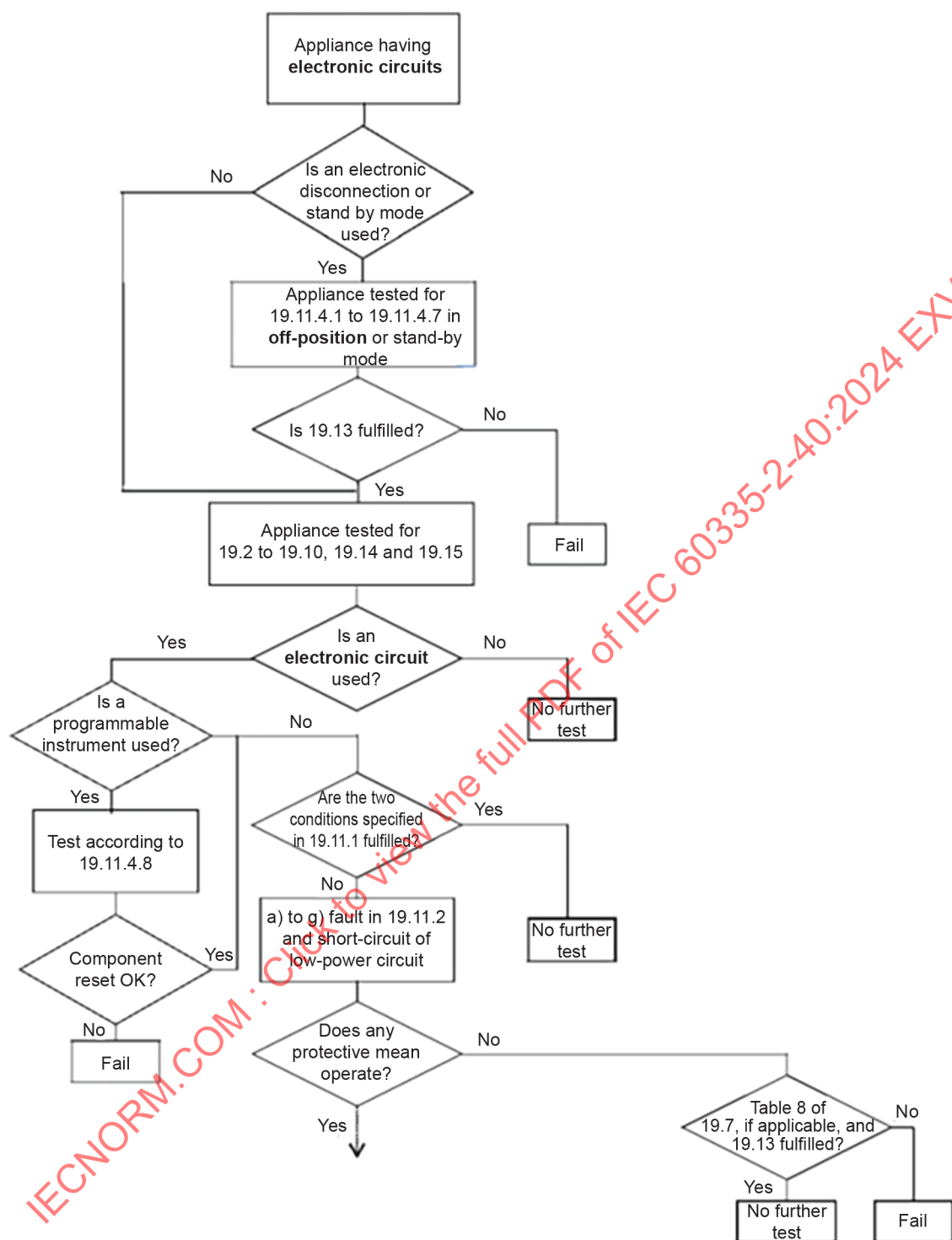


Figure Q.1 – Flowchart outlining the sequence of tests for the evaluation of electronic circuits (1 of 2)

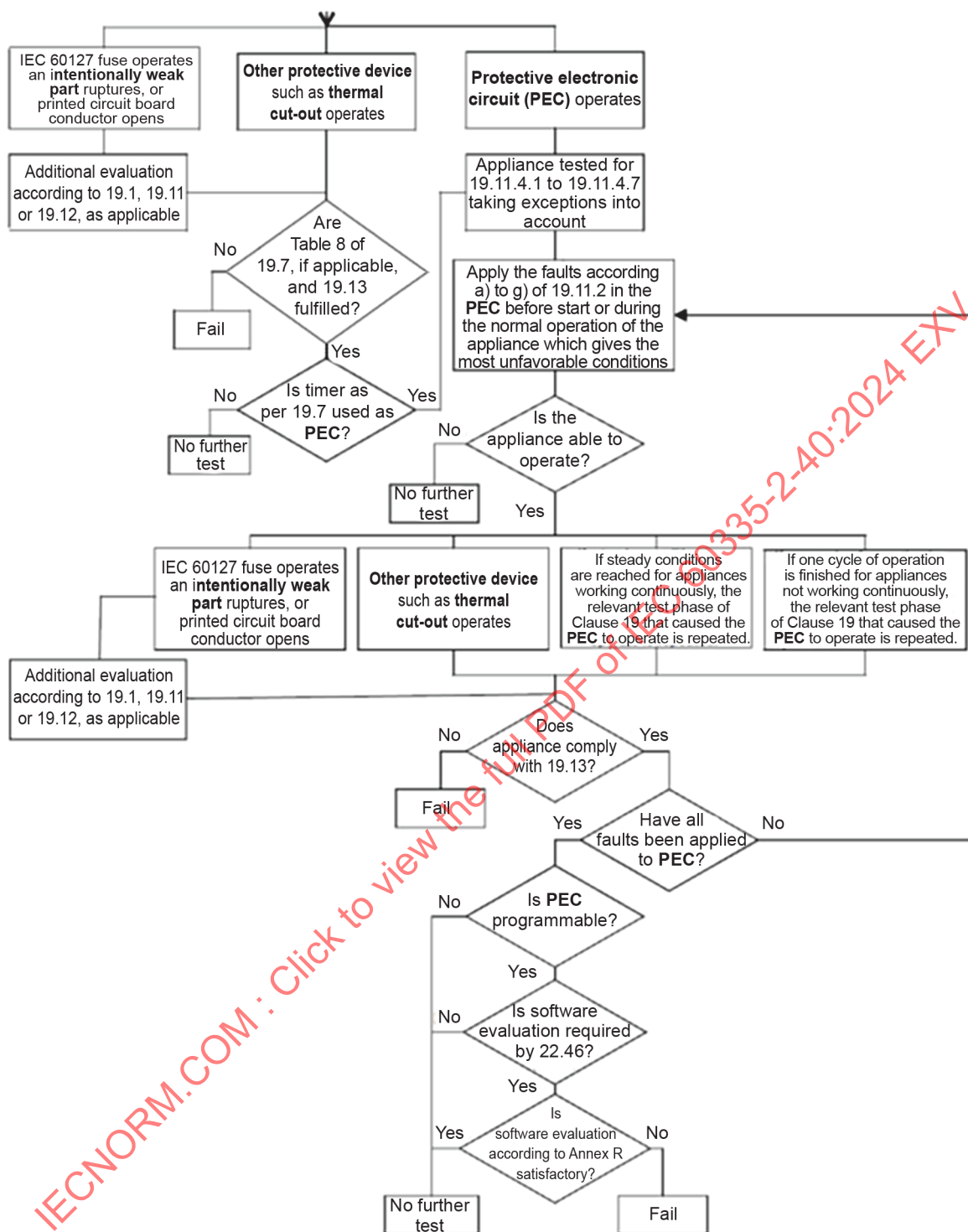


Figure Q.1 (2 of 2)

Annex R (normative)

Software evaluation

Programmable **electronic circuits** requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2 shall be validated in accordance with the requirements in this annex.

NOTE Tables R.1 and R.2 are based on Table H.1 of IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015 that is, for the purpose of this annex, divided in two tables, Table R.1 for general fault/error conditions and Table R.2 for specific fault/error conditions.

R.1 Programmable electronic circuits using software

Programmable **electronic circuits** requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2 shall be constructed so that the software does not impair compliance with the requirements of this standard.

Compliance is checked by the inspections and tests, according to the requirements of this annex, and by examination of the documentation as required by this annex.

R.2 Requirements for the architecture

R.2.1 General

R.2.1.1 Programmable **electronic circuits** requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2 shall use measures to control and avoid software-related faults/errors in safety-related data and safety-related segments of the software.

Compliance is checked by the inspections and tests in R.2.2 to R.3.4 inclusive.

R.2.1.2 Programmable **electronic circuits** requiring software incorporating measures to control the fault/error conditions specified in Table R.2 shall have one of the following structures:

- single channel with periodic self-test and monitoring (see IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015, H.2.16.7);
- dual channel (homogenous) with comparison (see IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015, H.2.16.3);
- dual channel (diverse) with comparison (see IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015, H.2.16.2).

NOTE 1 Comparison between dual channel structures can be performed by:

- use of a comparator (see IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015 H.2.18.3), or
- reciprocal comparison (see IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015 H.2.18.15).

Programmable **electronic circuits** requiring software incorporating measures to control the fault/error conditions specified in Table R.1 shall have one of the following structures:

- single channel with functional test (see IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015 H.2.16.5);
- single channel with periodic self-test (see IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015, H.2.16.6);
- dual channel without comparison (see IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015, H.2.16.1).

NOTE 2 Software structures incorporating measures to control the fault/error conditions specified in Table R.2 are also acceptable for programmable **electronic circuits** with functions requiring software measures to control the fault/error conditions specified in Table R.1.

Compliance is checked by the inspections and tests of the software architecture in R.3.2.2.

R.2.2 Measures to control faults/errors

R.2.2.1 When redundant memory with comparison is provided on two areas of the same component, the data in one area shall be stored in a different format from that in the other area (see software diversity, IEC 60730-1:2013 including IEC 60730-1:2013/AMD1:2015, H.2.18.19).

Compliance is checked by inspection of the source code.

R.2.2.2 Programmable **electronic circuits** with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.2 and that use dual channel structures with comparison shall have additional fault/error detection means (such as periodic functional tests, periodic self tests, or independent monitoring) for any fault/errors not detected by the comparison.

Compliance is checked by inspection of the source code.

R.2.2.3 For programmable **electronic circuits** with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2, means shall be provided for the recognition and control of errors in transmissions to external safety-related data paths. Such means shall take into account errors in data, addressing, transmission timing and sequence of protocol.

Compliance is checked by inspection of the source code.

R.2.2.4 For programmable **electronic circuits** with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2, the programmable **electronic circuits** shall incorporate measures to address the fault/errors in safety-related segments and data indicated in Table R.1 or Table R.2 as appropriate.

Compliance is checked by inspection of the source code.

Table R.1 – General fault/error conditions

Component ^a	Fault/error	Acceptable measures ^{b, c}	Definitions See IEC 60730-1:2013 including IEC 60730-1:2013/ AMD1:2015
1 Central processing unit (CPU)			
1.1 Registers	Stuck at	Functional test, or periodic self-test using either: – static memory test, or – word protection with single bit redundancy	H.2.16.5 H.2.16.6 H.2.19.6 H.2.19.8.2
1.2 VOID			
1.3 Programme counter	Stuck at	Functional test, or periodic self-test, or independent time-slot monitoring, or logical monitoring of the programme sequence	H.2.16.5 H.2.16.6 H.2.18.10.4 H.2.18.10.2
2 Interrupt handling and execution	No interrupt or too frequent interrupt	Functional test, or time-slot monitoring	H.2.16.5 H.2.18.10.4
3 Clock	Wrong frequency (for quartz synchronized clock: harmonics/sub-harmonics only)	Frequency monitoring, or time slot monitoring	H.2.18.10.1 H.2.18.10.4
4 Memory			
4.1 Invariable memory	All single bit faults	Periodic modified checksum, or multiple checksum, or word protection with single bit redundancy	H.2.19.3.1 H.2.19.3.2 H.2.19.8.2
4.2 Variable memory	DC fault	Periodic static memory test, or word protection with single bit redundancy	H.2.19.6 H.2.19.8.2
4.3 Addressing (relevant to variable and invariable memory)	Stuck at	Word protection with single bit redundancy including the address	H.2.19.8.2

Component ^a	Fault/error	Acceptable measures ^{b, c}	Definitions See IEC 60730-1:2013 including IEC 60730-1:2013/ AMD1:2015
5 Internal data path	Stuck at	Word protection with single bit redundancy	H.2.19.8.2
5.1 VOID			
5.2 Addressing	Wrong address	Word protection with single bit redundancy including the address	H.2.19.8.2
6 External communication			
6.1 Data	Data corruption of up to Hamming distance 3	Word protection with multi-bit redundancy, or CRC – single word, or transfer redundancy, or protocol test	H.2.19.8.1 H.2.19.4.1 H.2.18.2.2 H.2.18.14
6.2 Addressing	Wrong address	Word protection with multi-bit redundancy including the address or CRC – single word including the addresses, or transfer redundancy, or protocol test	H.2.19.8.1 H.2.19.4.1 H.2.18.2.2 H.2.18.14
6.3 Timing	Wrong point in time Wrong sequence	Time-slot monitoring, or scheduled transmission Logical monitoring, or time-slot monitoring, or scheduled transmission	H.2.18.10.4 H.2.18.18 H.2.18.10.2 H.2.18.10.4 H.2.18.18
7 Input/output periphery	Fault conditions specified in 19.11.2	Plausibility check	H.2.18.13
7.1 VOID			
7.2 Analog I/O			
7.2.1 A/D and D/A convertor	Fault conditions specified in 19.11.2	Plausibility check	H.2.18.13
7.2.2 Analog multiplexer	Wrong addressing	Plausibility check	H.2.18.13
8 VOID			
9 Custom chips ^d e.g. ASIC, GAL, gate array	Any output outside the static and dynamic functional specification	Periodic self-test	H.2.16.6

NOTE A Stuck-at fault model denotes a fault model representing an open circuit or a non-varying signal level. A DC fault model denotes a stuck-at fault model incorporating short circuits between signal lines.

- ^a For fault/error assessment, some components are divided into their sub-functions.
- ^b For each sub-function in the table, the Table R.2 measure will cover the software fault/error.
- ^c Where more than one measure is given for a sub-function, these are alternatives.
- ^d To be divided as necessary by the manufacturer into sub-functions.

Table R.2 – Specific fault/error conditions

Component ^a	Fault/error	Acceptable measures ^{b, c}	Definitions See IEC 60730-1:2013 including IEC 60730-1:2013/A MD1:2015
1 Central Processing Unit (CPU)			
1.1 Registers	DC fault	Comparison of redundant CPUs by either: – reciprocal comparison – independent hardware comparator, or - internal error detection, or - redundant memory with comparison, or - periodic self-tests using either – walkpat memory test – Abraham test – transparent GALPAT test; or - word protection with multi-bit redundancy, or - static memory test and - word protection with single bit redundancy	H.2.18.15 H.2.18.3 H.2.18.9 H.2.19.5 H.2.19.7 H.2.19.1 H.2.19.2.1 H.2.19.8.1 H.2.19.6 H.2.19.8.2
1.2 Instruction decoding and execution	Wrong decoding and execution	Comparison of redundant CPUs by either: – reciprocal comparison – independent hardware comparator, or - internal error detection, or - periodic self-test using equivalence class test	H.2.18.15 H.2.18.3 H.2.18.9 H.2.18.5
1.3 Programme counter	DC fault	Periodic self-test and monitoring using either: – independent time-slot and logical monitoring – internal error detection, or - comparison of redundant functional channels by either: – reciprocal comparison – independent hardware comparator	H.2.16.7 H.2.18.10.3 H.2.18.9 H.2.18.15 H.2.18.3

Component ^a	Fault/error	Acceptable measures ^{b, c}	Definitions See IEC 60730-1:2013 including IEC 60730-1:2013/A MD1:2015
1.4 Addressing	DC fault	Comparison of redundant CPUs by either: – reciprocal comparison – independent hardware comparator; or - internal error detection; or - periodic self-test using – a testing pattern of the address lines; or – a full bus redundancy – a multi bus parity including the address	H.2.18.15 H.2.18.3 H.2.18.9 H.2.16.7 H.2.18.22 H.2.18.1.1 H.2.18.1.2
1.5 Data paths instruction decoding	DC fault and execution	Comparison of redundant CPUs by either: – reciprocal comparison, or – independent hardware comparator, or – internal error detection, or – periodic self-test using a testing pattern, or – data redundancy, or – multi-bit bus parity	H.2.18.15 H.2.18.3 H.2.18.9 H.2.16.7 H.2.18.2.1 H.2.18.1.2
2 Interrupt handling and execution	No interrupt or too frequent interrupt related to different sources	Comparison of redundant functional channels by either – reciprocal comparison, – independent hardware comparator, or – independent time-slot and logical monitoring	H.2.18.15 H.2.18.3 H.2.18.10.3
3 Clock	Wrong frequency (for quartz synchronized clock: harmonics/ subharmonics only)	Frequency monitoring, or time-slot monitoring, or comparison of redundant functional channels by either: – reciprocal comparison – independent hardware comparator	H.2.18.10.1 H.2.18.10.4 H.2.18.15 H.2.18.3
4. Memory			
4.1 Invariable memory	99,6 % coverage of all information errors	Comparison of redundant CPUs by either: – reciprocal comparison – independent hardware comparator, or - redundant memory with comparison, or - periodic cyclic redundancy check, either – single word – double word, or - word protection with multi-bit redundancy	H.2.18.15 H.2.18.3 H.2.19.5 H.2.19.4.1 H.2.19.4.2 H.2.19.8.1

Component ^a	Fault/error	Acceptable measures ^{b, c}	Definitions See IEC 60730-1:2013 including IEC 60730-1:2013/A MD1:2015
4.2 Variable memory	DC fault and dynamic cross links	Comparison of redundant CPUs by either: – reciprocal comparison – independent hardware comparator, or redundant memory with comparison, or periodic self-tests using either: – walkpat memory test – Abraham test – transparent GALPAT test, or word protection with multi-bit redundancy	H.2.18.15 H.2.18.3 H.2.19.5 H.2.19.7 H.2.19.1 H.2.19.2.1 H.2.19.8.1
4.3 Addressing (relevant to variable and invariable memory)	DC fault	Comparison of redundant CPUs by either: – reciprocal comparison, or – independent hardware comparator, or full bus redundancy testing pattern, or periodic cyclic redundancy check, either: – single word – double word, or word protection with multi-bit redundancy including the address	H.2.18.15 H.2.18.3 H.2.18.1.1 H.2.18.22 H.2.19.4.1 H.2.19.4.2 H.2.19.8.1
5 Internal data path			
5.1 Data	DC fault	Comparison of redundant CPUs by either – reciprocal comparison – independent hardware comparator, or word protection with multi-bit redundancy including the address, or data redundancy, or testing pattern, or protocol test	H.2.18.15 H.2.18.3 H.2.19.8.1 H.2.18.2.1 H.2.18.22 H.2.18.14
5.2 Addressing	Wrong address and multiple addressing	Comparison of redundant CPUs by: – reciprocal comparison – independent hardware comparator, or word protection with multi-bit redundancy, including the address, or full bus redundancy; or testing pattern including the address	H.2.18.15 H.2.18.3 H.2.19.8.1 H.2.18.1.1 H.2.18.22

Component ^a	Fault/error	Acceptable measures ^{b, c}	Definitions See IEC 60730-1:2013 including IEC 60730-1:2013/A MD1:2015
6 External communication			
6.1 Data	Data corruption of up to Hamming distance 4	CRC – double word, or data redundancy or comparison of redundant functional channels by either – reciprocal comparison; or – independent hardware comparator	H.2.19.4.2 H.2.18.2.1 H.2.18.15 H.2.18.3
6.2 Addressing	Wrong address and multiple addressing	CRC – double word, including the address, or full bus redundancy of data and address, or comparison of redundant communication channels by either: – reciprocal comparison; or – independent hardware comparator	H.2.19.4.2 H.2.18.1.1 H.2.18.15 H.2.18.3
6.3 Timing	Wrong point in time Wrong sequence	Time-slot and logical monitoring, or comparison of redundant communication channels by either: – reciprocal comparison; or – independent hardware comparator Time-slot and logical monitoring, or comparison of redundant communication channels by either: – reciprocal comparison; or – independent hardware comparator	H.2.18.10.3 H.2.18.15 H.2.18.3 H.2.18.10.3 H.2.18.15 H.2.18.3
7 Input/output periphery			
7.1 Digital I/O	Fault conditions specified in 19.11.2	Comparison of redundant CPUs by either: – reciprocal comparison – independent hardware comparator, or input comparison, or multiple parallel outputs, or output verification, or testing pattern, or code safety	H.2.18.15 H.2.18.3 H.2.18.8 H.2.18.11 H.2.18.12 H.2.18.22 H.2.18.2

Component ^a	Fault/error	Acceptable measures ^{b, c}	Definitions See IEC 60730-1:2013 including IEC 60730-1:2013/A MD1:2015
7.2 Analog I/O			
7.2.1 A/D- and D/A- convertor	Fault conditions in 19.11.2	Comparison of redundant CPUs by either: – reciprocal comparison – independent hardware comparator, or input comparison, or multiple parallel outputs, or output verification, or testing pattern	H.2.18.15 H.2.18.3 H.2.18.8 H.2.18.11 H.2.18.12 H.2.18.22
7.2.2 Analog multiplexer	Wrong addressing	Comparison of redundant CPUs by either: – reciprocal comparison – independent hardware comparator, or input comparison or testing pattern	H.2.18.15 H.2.18.3 H.2.18.8 H.2.18.22
8 Monitoring devices and comparators	Any output outside the static and dynamic functional specification	Tested monitoring, or redundant monitoring and comparison, or error recognizing means	H.2.18.21 H.2.18.17 H.2.18.6
9 Custom chips ^d e.g. ASIC, GAL, gate array	Any output outside the static and dynamic functional specification	Periodic self-test and monitoring, dual channel (diverse) with comparison, or error recognizing means	H.2.16.7 H.2.16.2 H.2.18.6
NOTE A DC fault model denotes a stuck-at fault model incorporating short circuits between signal lines.			
^a For fault/error assessment, some components are divided into their sub-functions.			
^b For each sub-function in the table, the software measure will cover the Table R.1 fault/error.			
^c Where more than one measure is given for a sub-function, these are alternatives.			
^d To be divided as necessary by the manufacturer into sub-functions.			

R.2.2.5 For programmable **electronic circuits** with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2, detection of a fault/error shall occur before compliance with Clause 19 is impaired.

For appliances intended for **remote communication** through **public networks**, where normative Annex U is applicable as determined by 22.62, detection of a fault/error shall occur before compliance with normative Annex U is impaired.

Compliance is checked by inspection and testing of the source code.

NOTE The loss of dual channel capability is deemed to be an error in a programmable **electronic circuit** using a dual channel structure required for software to control the fault/error conditions specified in Table R.2.

R.2.2.6 The software shall be referenced to relevant parts of the operating sequence and the associated hardware functions.

Compliance is checked by inspection of the source code.

R.2.2.7 Where labels are used for memory locations, these labels shall be unique.

Compliance is checked by inspection of the source code.

R.2.2.8 The software shall be protected from user alteration of safety-related segments and data.

Compliance is checked by inspection of the source code.

R.2.2.9 The software and safety-related hardware under its control shall be initialized and shall terminate before compliance with Clause 19 is impaired. In addition, for appliances intended for **remote communication** through **public networks** where normative Annex U is applicable as determined by 22.62, the software and safety-related hardware under its control shall be initialized and shall terminate before compliance with normative Annex U is impaired.

Compliance is checked by testing of the source code.

R.3 Measures to avoid errors

R.3.1 General

For programmable **electronic circuits** with functions requiring software incorporating measures to control the fault/error conditions specified in Table R.1 or Table R.2, the following measures to avoid systematic faults in the software shall be applied.

Software that incorporates measures used to control the fault/error conditions specified in Table R.2 is inherently acceptable for software required to control the fault/error conditions specified in Table R.1.

NOTE The content of these requirements is extracted from IEC 61508-3:2010 and adapted to the needs of this standard.

R.3.2 Specification

R.3.2.1 Software safety requirements

The specification of the software safety requirements shall include:

- a description of each safety related function to be implemented, including its response time(s);
 - functions related to the application including their related software faults required to be controlled;
 - functions related to the detection, annunciation and management of software or hardware faults.
- a description of interfaces between software and hardware;
- a description of interfaces between any safety and non-safety related functions;
- a description of any compiler used to generate the object code from the source code, including details of any compiler switch settings used such as library function options, memory model, optimization, SRAM details, clock rate and chip details;
- a description of any linker used to link the object code to executable library routines.

Compliance is checked by inspection of the documentation and as specified in R.3.2.2.2.

NOTE Examples of some techniques/measures to meet these requirements can be found in Table R.3.

Table R.3 – Semi-formal methods

<i>Technique / Measure</i>	<i>Informative references</i>
<i>Semi-formal methods</i>	
<i>Logical/functional block diagrams</i>	
<i>Sequence diagrams</i>	
<i>Finite state machines/state transition diagrams</i>	<i>IEC 61508-7:2010, B.2.3.2</i>
<i>Decision/truth tables</i>	<i>IEC 61508-7:2010, C.6.1</i>

R.3.2.2 Software architecture

R.3.2.2.1 The specification of the software architecture shall include the following aspects:

- techniques and measures to control software faults/errors (refer to R.2.2);
- interactions between hardware and software;
- partitioning into modules and their allocation to the specified safety functions;
- hierarchy and call structure of the modules (control flow);
- interrupt handling;
- data flow and restrictions on data access;
- architecture and storage of data;
- time-based dependencies of sequences and data.

Compliance is checked by inspection of the documentation and as specified in R.3.2.2.2.

NOTE Examples of some techniques/measures to meet these requirements can be found in Table R.4.

Table R.4 – Software architecture specification

<i>Technique / Measure</i>	<i>Informative references</i>
<i>Fault detection and diagnosis</i>	<i>IEC 61508-7:2010, C.3.1</i>
<i>Semi-formal methods:</i>	
• <i>Logic/function block diagrams</i>	
• <i>Sequence diagrams</i>	
• <i>Finite state machines / state transition diagrams</i>	<i>IEC 61508-7:2010, B.2.3.2</i>
• <i>Data flow diagrams</i>	<i>IEC 61508-7:2010, C.2.2</i>

R.3.2.2.2 *The architecture specification shall be validated against the specification of the software safety requirements by static analysis.*

NOTE Example methods for static analysis are:

- control flow analysis; (IEC 61508-7:2010, C.5.9);
- data flow analysis; (IEC 61508-7:2010, C.5.10);
- walk-through (software) (IEC 61508-7:2010, C.5.15);
- design review (IEC 61508-7:2010, C.5.16).

R.3.2.3 Module design and coding

R.3.2.3.1 Based on the architecture design, software shall be suitably refined into modules. Software module design and coding shall be implemented in a way that is traceable to the software architecture and requirements.

The module design shall specify:

- function(s);
- interfaces to other modules;
- data.

Compliance is checked by R.3.2.3.3 and by inspection of the documentation.

NOTE 1 The use of computer aided design tools is accepted.

NOTE 2 Defensive programming (IEC 61508-7:2010, Subclause C.2.5) is recommended (e.g. range checks, check for division by 0, plausibility checks).

NOTE 3 Examples of some techniques/measures to meet these requirements can be found in Table R.5.

Table R.5 – Module design specification

Technique / Measure	Informative references
<i>Limited size of software modules</i>	IEC 61508-7:2010, C.2.9
<i>Information hiding / encapsulation</i>	IEC 61508-7:2010, C.2.8
<i>One entry / one exit point in subroutines and functions</i>	IEC 61508-7:2010, C.2.9
<i>Fully defined interface</i>	IEC 61508-7:2010, C.2.9
<i>Semi-formal methods:</i> • <i>Logic/function block diagrams</i> • <i>Sequence diagrams</i> • <i>Finite state machines / state transition diagrams</i> • <i>Data flow diagrams</i>	IEC 61508-7:2010, B.2.3.2 IEC 61508-7:2010, C.2.2

R.3.2.3.2 Software code shall be structured.

Compliance is checked by R.3.2.3.3 and by inspection of the documentation.

NOTE 1 Structural complexity can be minimized by applying the following principles:

- keep the number of possible paths through a software module small, and the relation between the input and output parameters as simple as possible;
- avoid complicated branching and, in particular, avoid unconditional jumps (GOTO) in higher level languages;
- where possible, relate loop constraints and branching to input parameters;
- avoid using complex calculations as the basis of branching and loop decisions.

NOTE 2 Examples of some techniques/measures to meet these requirements can be found in Table R.6.

Table R.6 – Design and coding standards

Technique / Measure	Informative references
<i>Use of coding standard (see NOTE)</i>	<i>IEC 61508-7:2010, C.2.6.2</i>
<i>No use of dynamic objects and variables (see NOTE)</i>	<i>IEC 61508-7:2010, C.2.6.3</i>
<i>Limited use of interrupts</i>	<i>IEC 61508-7:2010, C.2.6.5</i>
<i>Limited use of pointers</i>	<i>IEC 61508-7:2010, C.2.6.6</i>
<i>Limited use of recursion</i>	<i>IEC 61508-7:2010, C.2.6.7</i>
<i>No unconditional jumps in programs in higher level languages</i>	<i>IEC 61508-7:2010, C.2.6.2</i>
NOTE Dynamic objects and/or variables are allowed if a compiler is used which ensures that sufficient memory for all dynamic objects and/or variables will be allocated before runtime, or which inserts runtime checks for the correct online allocation of memory.	

R.3.2.3.3 *Coded software shall be validated against the module specification by static analysis. The module specification shall be validated against the architecture specification by static analysis.*

R.3.3 Software validation

The software shall be validated with reference to the requirements of the software safety requirements specification.

NOTE 1 Validation is confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled. Therefore, for example, software validation means confirming by examination and provision of objective evidence that the software satisfies the software safety requirements specification.

Compliance is checked by simulation of:

- *input signals present during **normal operation**;*
- *anticipated occurrences;*
- *undesired conditions requiring system action.*

Test cases, test data and test results shall be reported.

NOTE 2 Examples of some techniques/measures to meet these requirements can be found in Table R.7.

Table R.7 – Software safety validation

Technique / Measure	Informative references
<i>Functional and black-box testing:</i>	<i>IEC 61508-7:2010, B.5.1, B.5.2</i>
• <i>Boundary value analysis</i>	<i>IEC 61508-7:2010, C.5.4</i>
• <i>Process simulation</i>	<i>IEC 61508-7:2010, C.5.18</i>
<i>Simulation, modelling:</i>	
• <i>Finite state machines</i>	<i>IEC 61508-7:2010, B.2.3.2</i>
• <i>Performance modelling</i>	<i>IEC 61508-7:2010, C.5.20</i>

R.3.4 Management items

R.3.4.1 Management of software versions

A software version management system at the module level shall be put in place. All versions shall be uniquely identified for traceability.

NOTE The use of a version ID number, if unique, is one possible solution.

Compliance is checked by inspection of the documentation.

R.3.4.2 Software modification

R.3.4.2.1 Software modifications shall be based on a modification request which details the following:

- the hazards which may be affected;
- the proposed change;
- the reasons for change.

R.3.4.2.2 An analysis shall be carried out to determine the impact of the proposed modification on functional safety.

R.3.4.2.3 A detailed specification for the modification shall be generated including the necessary activities for verification and validation, such as a definition of suitable test cases.

R.3.4.2.4 The modification shall be carried out as planned.

R.3.4.2.5 The assessment of the modification shall be carried out based on the specified verification and validation activities. This may include:

- a reverification of changed software modules;
- a reverification of affected software modules;
- a revalidation of the complete system.

R.3.4.2.6 All details of modification activities shall be documented.

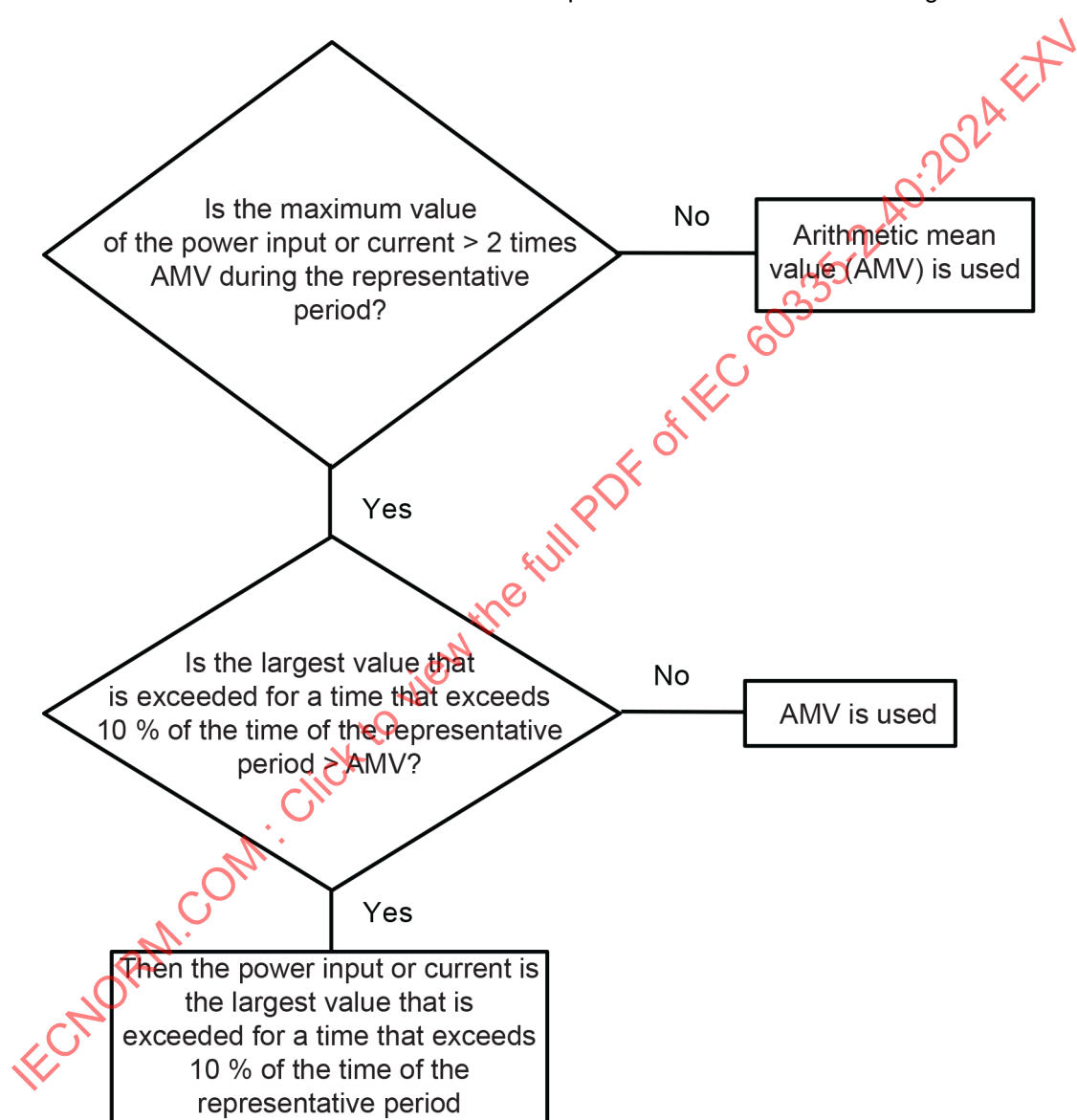
Compliance of the requirements in R.3.4.2.1 to R.3.4.2.6 is checked by inspection of the documentation.

Annex S

(informative)

Guidance for the application of this standard on measurement of power input and current based on the requirements of 10.1 and 10.2 concerning the representative period

For correct application of this standard, the normative text takes precedence over the guidance given in this annex and reliance should not to be placed on the flow chart of Figure S.1.



IEC

Figure S.1 – Flowchart giving guidance on measurement of power input and current concerning the representative period

Annex T (normative)

UV-C radiation effect on non-metallic materials

This annex provides requirements for non-metallic materials subject to direct or reflected UV-C radiation (100 nm to 280 nm) exposure and whose mechanical and electrical properties are relied upon for compliance with this standard. This annex does not apply to glass, ceramic and similar materials.

NOTE General-purpose incandescent and fluorescent lamps with ordinary glass envelopes are not considered to emit significant UV-C radiation.

The UV-C radiation effect on non-metallic materials is determined by measuring selected non-metallic material properties before and after UV-C radiation conditioning. The conditioning and tests are carried out on non-metallic material specimens prepared according to the relevant standard for the test method. The standards and compliance criteria for parts providing mechanical support or impact resistance are specified in Table T.1. The standard and compliance criteria for electrical insulation of internal wiring are specified in Table T.2.

The conditioning apparatus and test procedure are as specified in ISO 4892-1 and ISO 4892-2, with some of their clauses being as modified follows.

Modifications to the clauses of ISO 4892-1:2016.

5.1 Irradiance

5.1.1 *The UV-C emitter shall be a low pressure mercury lamp with a quartz envelope having a continuous spectral irradiance of 10 W/m² at 254 nm.*

NOTE The quartz envelope blocks the 185 nm resonant wavelength for mercury that can generate ozone.

5.2 Temperature

5.2.5 *The black-panel temperature shall be 63 °C ± 3 °C.*

5.3 Humidity and wetting

5.3.1 *Humidification of the chamber air is specified in part 2 when necessary.*

9 Test report

This clause is not applicable.

Modifications to the clauses of ISO 4892-2:2013.

7 Procedure

7.1 General

At least three test specimens of each non-metallic material providing mechanical support or impact resistance shall be exposed in each run to allow statistical evaluation of the results.

Ten samples of the insulated internal wiring shall be exposed in each run. When the internal wiring is provided in more than one colour, the colour having the heaviest organic pigment loading is used.

In determining the samples for testing, consideration should be given to samples coloured red or yellow which are known to have particular critical effects.

7.2 Mounting the test specimens

The specimens shall be attached to the specimen holders such that they are not subject to any applied stress.

7.3 Exposure

Before placing the specimens in the test chamber, the apparatus shall be operating under the specified exposure conditions. It shall be programmed to operate continuously and the conditions shall be maintained throughout the exposure, keeping any interruptions to service the apparatus and to inspect the specimens to a minimum.

The test specimens and, if used, the irradiance-measuring instrument are exposed for 1 000 h.

NOTE Repositioning of the specimens during exposure is desirable and might be necessary.

If it is necessary to remove a test specimen for periodic inspection, care should be taken to avoid touching the exposed surface or altering it in any way.

7.4 Measurement of radiant exposure

If used, a radiometer shall be mounted and calibrated such that it measures the irradiance at the exposed surface of the test specimen.

7.5 Determination of changes in properties after exposure

The non-metallic material properties and test methods for parts providing mechanical support or impact resistance are specified in Table T.1.

Table T.1 – Minimum property retention limits after UV-C exposure

Parts to be tested	Property	Standard for the test method	Minimum retention after test ^d
Parts providing mechanical support	Tensile strength ^a or	ISO 527 (all parts)	70 %
	Flexural strength ^{a,b}	ISO 178	70 %
Parts providing impact resistance	Charpy impact ^c or	ISO 179-1	70 %
	Izod impact ^c or	ISO 180	70 %
	Tensile impact ^c	ISO 8256	70 %
^a Tensile strength and flexural strength tests are to be conducted on specimens no thicker than the actual thicknesses. ^b The side of the sample exposed to UV-C radiation is to be in contact with the two loading points when using the three point loading method. ^c Tests conducted on 3,0 mm thick specimens for Izod impact and tensile impact tests and 4,0 mm thick specimens for Charpy impact tests are considered representative of other thicknesses, down to 0,8 mm. ^d Test specimens shall also show no visible signs of deterioration, such as crazing or cracking.			

The non-metallic material properties and test method for electrical insulation of internal wiring are specified in Table T.2.

Table T.2 – Minimum electric strength for internal wiring after UV-C exposure

Parts to be tested	Property	Standard for the test method	Compliance
Electrical insulation of internal wiring	Electric strength	IEC 60335-1 Subclause 23.5	No breakdown shall occur during the test.

8 Exposure report

This clause is not applicable.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex U (normative)

Appliances intended for remote communication through public networks

The measures given in this annex are intended to avoid unauthorized access and the effects of transmission failures via **remote communication** through **public networks**, where compliance with this standard could be impaired.

However, in general, it does not cover aspects concerning confidentiality of data and consumer privacy.

U.1 Terms and definitions

U.1.1 Definitions relating to remote functionality

U.1.1.1

authentication

provision for confirming that the **entity** sending or receiving a **message** is what or who it claims to be

U.1.1.2

authorization

means to ensure that the authenticated **entity** requesting access to information, functions or services has the required authority

U.1.1.3

cryptographic technique

calculation of output data using a mathematical algorithm to encode input data with a key as a parameter

U.1.1.4

data integrity protection

protection that enables the appliance to confirm the data has not been altered, lost or destroyed

U.2 Marking and instructions

U.2.1 If there is provision for software download, instructions shall be provided on how or where to obtain the unique name or code given by the manufacturer, that identifies the current version of the software running in the appliance. The instructions shall also include the necessary steps the user must follow for the software update procedure.

Compliance is checked by inspection.

U.3 Construction

U.3.1 Software enabling communication with a **public network** shall be partitioned into modules separate from software which is necessary to comply with the other requirements of this standard.

Compliance is checked by inspection.

U.3.2 Remote communication shall be established, implemented and terminated by the appliance via software that provides

- **data integrity protection** concerning:
 - data corruption;
 - address corruption;
 - wrong timing or sequence;
 - permanent "auto-sending" or repetition;
 - interruption of data transfer;
- means to detect and respond to communication in which, for any reason, a **message** being communicated is incomplete, truncated, contains errors or has the correct format but delivers information that is outside the range expected for that type of **message**; and
- measures to control the fault/error conditions specified in Table R.1.

Compliance is checked by the inspections and tests of the software architecture in R.3.2.2 and evaluating the software in accordance with R.3.3.

U.3.3 Measures shall be provided to protect against hazards arising from the reception of **messages** from several sources simultaneously or sequentially.

Compliance is checked by evaluation according to U.3.2.

U.3.4 Remote communication shall not be enabled prior to **authorization**. **Authorization** shall be based on **authentication**. The **authentication** process shall use **cryptographic techniques** to ensure the identity of both parties.

For the purposes of this requirement, communication between two **entities** for preparation of the **authentication** and **authorization** process is not considered **remote communication**.

Compliance is checked by inspection of the software.

U.3.5 Measures shall be taken to prevent unauthorized access and to detect transmission faults/errors in the **remote communication**.

NOTE Examples of acceptable hardware-software measures are provided in Table U.1.

Compliance is checked by evaluation according to U.3.2.

Table U.1 – Examples of acceptable measures against unauthorised access and transmission fault/error modes

Measures									
To cover	Threats	Sequence number ^a	Time stamp ^b	Timeout ^c	Feedback message ^d	Source and destination identifier ^e	Identification procedure ^f	Safety code ^g	Cryptographic techniques
Transmission failure modes ⁷	Repetition of a message	X	X						
	Deletion of message	X							
	Insertion of message	X			X	X	X		
	Re-sequence message	X	X						
	Corrupted, deleted or inserted data in a message							X ⁱ	X
	Delay in sending/ receiving the message		X	X					
Unauthorized access	Masquerade ^j				X		X		X
NOTE 1 Examples of acceptable measures against unauthorized access can also be found in IEC 62280.									
^a Additional data field containing a number that changes in a predefined way from message to message . ^b Information concerning time of transmission attached to a message by the sender. ^c Delay between two messages exceeding a predefined allowed maximum time. If this is the case, an error can be assumed. ^d Response from a receiver to a sender, via a return channel. ^e Identifier which is assigned to each entity . This identifier can be a name, number or arbitrary bit pattern. This identifier will be used for the safety-related communication. Usually the identifier is added to the user data. ^f Procedure that enables entities to confirm the identity of each other. ^g Redundant data included in a safety-related message to permit data corruptions to be detected by the safety-related transmission function. ^h These failure modes are of random and systematic nature. ⁱ See Table R.1 or Table R.2, component 6, with respect to external communication. ^j Masquerade: Making an inauthentic message look like an authentic message by an unauthorized user.									

U.3.6 The safe operation of an appliance shall not depend on **remote communication**.

*Compliance is checked by evaluation according to U.3.2. In case of doubt, **remote communication** shall be rendered inoperative for the relevant tests of this standard.*

U.3.7 **Cryptographic techniques** shall be implemented to provide **data integrity protection** once **authorization** for **remote communication** is established.

The **cryptographic techniques** employed shall be part of the appliance including its accessories, and not rely upon part of the router or similar data transmission device itself, and shall be performed prior to transmission.

NOTE Examples of commonly accepted **data integrity protection** are defined and described in ISO/IEC 9796, ISO/IEC 9797, ISO/IEC 9798, ISO/IEC 10118, ISO/IEC 11770, ISO/IEC 14888, ISO/IEC 15946, ISO/IEC 18033, ISO/IEC 29192, as well as ISO/IEC 19772.

*Compliance is checked by inspection and review of technical documentation which proves adherence to the commonly accepted **data integrity protection** methods.*

U.3.8 Provisions shall be taken to ensure that software updates provided by the manufacturer and transmitted to the appliance via **remote communication** shall be verified prior to its installation:

- against corruption through communication;
- that the software version is compatible with the appliance for which the software version was designed.

Additionally, the software which performs the above-mentioned checks shall contain measures to control the fault/error conditions specified in Table R.1.

Compliance is checked by evaluating the software and the manufacturer's version management documentation in accordance with the relevant requirements of normative Annex R.

U.3.9 Permission for each installation of software in the appliance shall be given by the person responsible for the appliance.

User activation of a mode that enables automatic software updates is permitted.

Compliance is checked by inspection of technical documentation describing the permission procedure or by functional test.

U.3.10 The installation of software shall not impair compliance with the requirements of this standard during or after installation.

Compliance is checked by software inspection and relevant testing.

Examples for operating temperatures of the appliance

Table AA.1 – Examples for operating temperatures of the appliance

Function of appliance	Classification		Heating				Cooling			
			Outdoor assembly °C (inlet)		Indoor assembly °C (outlet)		Outdoor assembly °C (inlet)		Indoor assembly °C (outlet)	
			DB ^a	WB ^b	DB ^a	WB ^b	DB ^a	WB ^b	DB ^a	WB ^b
Outside air/ Recycled air	A7	A20	7	6	20	12	35	24	27	19
Exhaust air/ Recycled air	A20	A20	20	12	20	12	–	–	–	–
Exhaust air/ Fresh air	A20	A7	20	12	7	6	–	–	–	–
Outside air/Water	A7	W50	7	6	Water	50	35	24	Water	7
Exhaust air/Water	A20	W50	20	12	Water	50	–	–	–	–
Water/Water	W10	W50	Water	10	Water	50	Water	15	Water	7
Brine/Water	B0	W50	Brine	0	Water	50	Brine	15	Water	7
Brine/Recycled air	B0	A20	Brine	0	20	12	–	–	–	–
Water/Recycled air	W10	A20	Water	10	20	12	–	–	–	–
Water/Recycled air	W20	A20	Water	20	20	12	–	–	–	–
Dehumidification	Comfort Process		–	–					27	21
	Heat recovery (air cooled)						27	21	27	21
	Heat recovery (water cooled)						Water	24	27	21
Sanitary hot water heat pump										
Outside air/Water	A7	W45	7	6	Water	45	–	–	–	–
Ambient air/Water	A15	W45	15	12	Water	45	–	–	–	–
Exhaust air/Water	A20	W45	20	12	Water	45	–	–	–	–
Brine/Water	B0	W45	Brine	0	Water	45	–	–	–	–

NOTE Appliance can be classified according to function and temperature application as noted below:

Source	Outside air	Sink	Recycled air	Classification	A – A *
Exhaust air		Recycled air		A –	A –
Exhaust air		Outside air		A –	A –
Outside air		Water		A –	W –
Exhaust air		Water		A –	W –
Water		Water		W –	W –
Water		Recycled air		W –	A –
Brine		Recycled air		B –	A –
Brine		Water		B –	W –

* For example, A7 A20 indicates an appliance designed for an outside air operating temperature of 7 °C DB and an inside air operating temperature of 20 °C DB.

^a **DB: dry bulb temperature**

^b **WB: wet bulb temperature**

Annex BB (normative)

Selected information about refrigerants

Table BB.1 gives selected information about refrigerants.

Table BB.1 – Selected information about refrigerants

NOTE Annex BB is not a complete list of suitable refrigerants. This standard applies to any refrigerants as defined in the scope.

Refrigerant designation a	Description	Formula (nominal composition mass fraction %)	Safety group f	Auto ignition temperature	Hot surface ignition temperature g	Maximum allowable surface temperature g	Density b	Molar mass at nominal composition h	Molar mass at worst case formulation i	Lower flammability limit at nominal composition b,d h	Lower flammability limit at worst case formulation b,d i	Burning velocity, $S_{u,r}$ at 23 °C 50 % relative humidity at nominal composition	Burning velocity, $S_{u,r}$ at 27 °C dew point at nominal composition
				°C	°C (A2L only)	°C	kg/m ³	kg/kmol	kg/kmol	kg/m ³	kg/m ³	cm/s	cm/s
R32	Difluoromethane	CH ₂ F ₂	A2L	648	> 800	700	2,13	52,0	NA	0,306	NA	6,7	6,7
R50	Methane	CH ₄	A3	645	NA	645	0,65	16,0	NA	0,032	NA		
R143a	1,1,1-Trifluoroethane	CF ₃ CH ₃	A2L	750	ND	750	3,43	84,0	NA	0,282	NA		
R152a	1,1-Difluoroethane	CHF ₂ CH ₃	A2	455	NA	455	2,70	66,0	NA	0,130	NA		
R170	Ethane	CH ₃ CH ₃	A3	515	NA	515	1,23	30,1	NA	0,038	NA		
R290	Propane	CH ₃ CH ₂ CH ₃	A3	470	NA	470	1,80	44,1	NA	0,038	NA		
R600	n-Butane	CH ₃ CH ₂ CH ₂ CH ₃	A3	365	NA	365	2,37	58,1	NA	0,038	NA		
R600a	Isobutane	CH(CH ₃) ₂ CH ₃	A3	460	NA	460	2,37	58,1	NA	0,043	NA		
R1150	Ethylene	CH ₂ =CH ₂	A3	425	NA	ND	1,15	28,1	NA	0,036	NA		

Refrigerant designation a	Description	Formula (nominal composition mass fraction %)	Safety group f	Auto ignition temperature	Hot surface ignition temperature g	Maximum allowable surface temperature g	Density b	Molar mass c at nominal composition h	Molar mass c at worst case formulation i	Lower flammability limit b,d at nominal composition h	Lower flammability limit b,d at worst case formulation i	Burning velocity, $S_{u'}$ at 23 °C 50 % relative humidity at nominal composition	Burning velocity, $S_{u'}$ at 27 °C dew point at nominal composition
				°C	°C (A2L only)	°C	kg/m ³	kg/kmol	kg/kmol	kg/m ³	kg/m ³	cm/s	cm/s
R1132	1,1-difluoroethylene	CF ₂ =CH ₂	A2	ND	NA	ND	2,61	64,0	NA	0,131	NA		
R1270	Propylene	CH ₂ =CHCH ₃	A3	455	NA	455	1,72	42,1	NA	0,046	NA		
RE170	Dimethylether	(CH ₃) ₂ O	A3	235	NA	235	1,88	46,1	NA	0,064	NA		
R142b	1-chloro-1,1-difluoroethane	CH ₃ CClF ₂	A2L	750 ^e	ND	750	4,11	100,5	NA	0,329	NA		
R1234yf	2,3,3,3-tetrafluoro-1-propene	CF ₃ CF=CH ₂	A2L	405	> 800	700	4,66	114,0	NA	0,289	NA		
R1234ze(E)	Trans-1,3,3,3-tetrafluoro-1-propene	CF ₃ CF=CHF	A2L	368	> 800	700	4,66	114,0	NA	0,303	NA		
R-444A	R-32/152a/1234ze (E)	(12,0/5,0/83,0)	A2L	ND	> 800	700	4,03	96,7	95,2	0,324	0,319		
R-444B	R-32/152a/1234ze (E)	(41,5/10,0/48,5)	A2L	ND	> 800	700	3,02	72,8	73,0	0,277	0,276		
R-445A	R-744/134a/1234ze (E)	(6,0/9,0/85,0)	A2L	ND	ND	ND	4,29	103,1	104,7	0,341	0,347		
R-446A	R-32/1234ze(E)/600	(68,0/29,0/3,0)	A2L	ND	ND	ND	2,60	62,0	62,4	0,236	0,237		
R-447A	R-32/125/1234ze(E)	(68,0/3,5/28,5)	A2L	ND	ND	ND	2,61	63,0	63,1	0,304	0,331		
R-447B	R-32/125/1234ze (E)	(68,0/8,0/24,0)	A2L	ND	> 800	700	2,58	63,1	63,1	0,312	0,312		
R-451A	R-1234yf/134a	(89,8/10,2)	A2L	ND	> 800	700	4,71	112,7	112,7	0,322	0,341		
R-451B	R-1234yf/134a	(88,8/11,2)	A2L	ND	> 800	700	4,70	112,6	112,6	0,322	0,341		

Refrigerant designation a	Description	Formula (nominal composition mass fraction %)	Safety group f	Auto ignition temperature	Hot surface ignition temperature g	Maximum allowable surface temperature g	Density b	Molar mass c at nominal composition h	Molar mass c at worst case formulation i	Lower flammability limit b,d at nominal composition h	Lower flammability limit b,d at worst case formulation i	Burning velocity, $S_{u'}$ at 23 °C 50 % relative humidity at nominal composition	Burning velocity, $S_{u'}$ at 27 °C dew point at nominal composition
				°C	°C (A2L only)	°C	kg/m ³	kg/kmol	kg/kmol	kg/m ³	kg/m ³	cm/s	cm/s
R-452B	R-32/125/1234yf	(67,0/7,0/26,0)	A2L	509	> 800	700	2,63	63,5	63,5	0,309	0,310	< 4,0	
R-454A	R-32/1234yf	(35,0/65,0)	A2L	457	> 800	700	3,34	80,5	81,8	0,273	0,281	< 4,0	
R-454B	R-32/1234yf	(68,9/31,1)	A2L	496	> 800	700	2,59	62,6	63,0	0,307	0,296	5,7	
R-454C	R-32/1234yf	(21,5/78,5)	A2L	444	> 800	700	3,78	90,8	92,5	0,286	0,291	< 4,0	
R-455A	R-744/32/1234yf	(3,0/21,5/75,5)	A2L	ND	> 800	700	3,64	87,5	89,4	0,422	0,431		
R-457A	R-32/1234yf/152a	(18,0/70,0/12,0)	A2L	ND	ND	ND	3,65	87,6	88,0	0,215	0,216		
R-459A	R-32/1234yf/1234ze(E)	(68,0/26,0/6,0)	A2L	ND	ND	ND	2,61	63,0	63,6	0,276	0,279		
R-459B	R-32/1234yf/1234ze(E)	(21,0/69,0/10,0)	A2L	ND	ND	ND	3,79	91,2	92,1	0,369	0,373		
R-462A	R-32/125/143a/134a/600	(9,0/42,0/2,0/44,0/3,0)	A2L	ND	ND	ND	4,04	91,1	67,8	0,230	0,291		

Refrigerant designation a	Description	Formula (nominal composition mass fraction %)	Safety group f	Auto ignition temperature	Hot surface ignition temperature g	Maximum allowable surface temperature g	Density b	Molar mass c at nominal composition h	Molar mass c at worst case formulation i	Lower flammability limit b,d at nominal composition h	Lower flammability limit b,d at worst case formulation i	Burning velocity, S_u , at 23 °C relative humidity at nominal composition	Burning velocity, S_u , at 27 °C dew point at nominal composition
R-465A	R-32/290/1234yf	(21, 0/7, 9/71, 1)	A2L	°C	°C (A2L only)	°C	kg/m ³	kg/kmol	kg/kmol	kg/m ³	kg/m ³	cm/s	cm/s
				ND	ND	ND	3,45	82,9	83,6	0,159	0,161		

If any data in this table is missing or in conflict with the data in ISO 817, then the value in ISO 817 shall take precedence. Where the **LFL** at nominal composition is not given, the **LFL** at worst case formulation shall be used.

The tables with ISO 817 refrigerant data are provided at <https://standards.iso.org/iso/817/ma/en/>.

ND means non-determined. Consult the safety data sheet of the manufacturer.

NA means not applicable.

a The refrigerant designations are in accordance with ISO 817.

b These values are at 25 °C and at 1 013,2 mbar.

c For comparison, the molecular mass of air is taken equal to 28,8 kg/kmol.

d Multiply % v/v by the corresponding molar mass × 0,000 409 to give the flammability limit in kg/m³.

e Estimated from molecular structure.

f Safety group of refrigerants based upon ISO 817.

g For **flammable refrigerants**, the maximum allowable surface temperature is determined by **AIT**. For **A2L refrigerants**, the maximum allowable surface temperature is determined by the highest of **AIT** or, if tested per Annex KK, the **hot surface ignition temperature** reduced by 100 K.

h Nominal composition means design composition as stated in the refrigerant blend application, excluding any tolerances.

i Worst case formulation means the composition that results from application of the tolerances to the nominal composition resulting in the most toxic or most flammable formulation.

Annex CC (informative)

Transportation, marking and storage for units that employ flammable refrigerants

CC.1 General

The following information is provided for units that employ **flammable refrigerants**.

CC.2 Transport of equipment containing flammable refrigerants

Attention is drawn to the fact that additional transportation regulations can exist with respect to equipment containing flammable gas. The maximum number of pieces of equipment or the configuration of the equipment permitted to be transported together will be determined by the applicable transport regulations.

CC.3 Marking of equipment using signs

Signs for similar appliances used in a work area are generally addressed by local regulations and give the minimum requirements for the provision of safety and/or health signs for a work location.

All required signs are to be maintained and employers should ensure that employees receive suitable and sufficient instruction and training on the meaning of appropriate safety signs and the actions that should be taken in connection with these signs.

The effectiveness of signs should not be diminished by too many signs being placed together.

Any pictograms used should be as simple as possible and contain only essential details.

CC.4 Disposal of equipment using flammable refrigerants

See national regulations.

CC.5 Storage of equipment/appliances

The storage of the appliance should be in accordance with the applicable regulations or instructions, whichever is more stringent.

CC.6 Storage of packed (unsold) equipment

Storage package protection should be constructed in such a way that mechanical damage to the equipment inside the package will not cause a leak of the **refrigerant charge**.

The maximum number of pieces of equipment permitted to be stored together will be determined by local regulations.

Annex DD (normative)

Requirements for installation, service, maintenance and repair, and decommissioning instructions of appliances using flammable refrigerants

DD.1 General

Each of the instructions shall include requirements of clauses according to Table DD.1. Different instructions can be combined into one document.

Numerical values necessary for proper installation, service, maintenance and repair, and decommissioning shall be in the form of a single figure or a table without reference to a formula.

For **factory sealed single package units**, it is not necessary for the installation instructions to include material from DD.4.8 and Clause DD.9.

Table DD.1 – Mandatory clauses in each of the instructions

Clause/subclause	Installation	Service, maintenance and repair	Decommissioning	Note
DD.2	Yes	Yes	Yes	
DD.3.1	Yes	Yes	No	
DD.3.2	Yes	Yes	No	User instructions also
DD.3.3	Yes	Yes	Yes	
DD.4	No	Yes	Yes	
DD.4.1	No	Yes	Yes	
DD.4.2	No	Yes	Yes	
DD.4.3	No	Yes	Yes	
DD.4.4	No	Yes	Yes	
DD.4.5	No	Yes	Yes	
DD.4.6	No	Yes	Yes	
DD.4.7	No	Yes	Yes	
DD.4.8	Yes	Yes	No	
DD.4.9	No	Yes	No	
DD.5	No	Yes	No	
DD.6	Yes	Yes	No	
DD.7	Yes	Yes	Yes	
DD.8	No	Yes	Yes	
DD.9	Yes	Yes	No	
DD.10	No	No	Yes	
DD.11	No	No	Yes	
DD.12	No	Yes	Yes	

DD.2 Symbols

The symbols referred to in 7.6 (without colours is permitted) and the information of the warning marking shall be provided as follows:

WARNING

Do not use means to accelerate the defrosting process or to clean, other than those recommended by the manufacturer.

The appliance shall be stored in a room without continuously operating ignition sources (for example: open flames, an operating gas appliance or an operating electric heater).

Do not pierce or burn.

Be aware that refrigerants might not contain an odour.

The manufacturer may provide other suitable examples or may provide additional information about the refrigerant odour.

DD.3 Information in instructions

DD.3.1 General

The following information shall be specified in the instructions where the information is necessary for the function of the instructions and as applicable to the appliance:

- 1) information for spaces where field-installed refrigerant pipes are allowed, including statements
 - a) that the installation of pipe-work shall be kept to a minimum;
 - b) that pipe-work shall be securely mounted and guarded from physical damage;
 - c) that pipe-work shall not be installed in an unventilated space, if that space is smaller than $A_{\min}$ in Annex GG, except for A2L refrigerants where installed pipe-work has no connecting joints or is connected with at least one of the following:
 - i) joints in compliance with ISO 14903,
 - ii) joints in enclosures which vent to the unit or to the outside,
 - iii) joints in enclosures which vent to a room with a room area of at least $A_{\min}$ as specified in GG.2.1;
 - d) that national gas regulations can impose additional requirements;
 - e) that mechanical connections made in accordance with 22.118 shall be accessible for maintenance purposes;
- 2) where addition of charge is required to complete installation, instructions on how to determine the additional **refrigerant charge** and how to complete the **refrigerant charge** on the label provided by the manufacturer considering the requirements in 7.107. Interconnecting refrigerant piping length and diameter shall be taken into consideration;
- 3) where **safety shut-off valves** are installed, instructions on how to determine the **releasable charge**, m_{r1} . **Safety shut-off valve** location and refrigerant piping volume between **safety shut-off valve** and the indoor unit shall be taken into consideration;

4) detailed instructions on how to correctly install the appliance including piping and safety shut-off valves for every space in which refrigerant can leak into, where applicable:

- a) minimum room area, $A_{\min}$, or minimum room area of conditioned space $TA_{\min}$, as a function of the **refrigerant charge**, m_c , or as a function of the **releasable charge**, m_{rl} . If the **releasable charge**, m_{rl} , has been used, a warning that the minimum room area or minimum room area of conditioned space is based on **releasable charge** and is not related to total system **refrigerant charge**;
- b) **refrigerant charge**, m_c , and, if the **releasable charge**, m_{rl} , has been determined, the **releasable charge**, m_{rl} . The effect on **refrigerant charge** shall be considered from field-installed piping, field charging, or both, if applicable;
- c) required **installed height**, h_{inst} ;
- d) minimum ventilation airflow volume $Q_{\min}$;
- e) minimum opening area for natural ventilation $A_{\text{nv},\min}$.

Additional minimum room area data may be provided based on other **installed heights** and/or charge levels;

- 5) information for handling, installation, cleaning, servicing and disposal;
- 6) for appliances intended for use at altitudes 2 000 m and above, the instructions shall include how to adjust minimum room area, $A_{\min}$, and minimum room area of conditioned space, $TA_{\min}$, as applicable from Annex GG, based on the building site ground level altitude;
- 7) a warning to keep any required ventilation openings clear of obstruction;
- 8) a notice that servicing shall be performed only as recommended by the manufacturer;
- 9) a warning that ducts connected to an appliance shall not contain a potential ignition source;
- 10) instructions for wiring to external zoning dampers and/or mechanical ventilation, if required to comply with Clause GG.9, to ensure that upon detection of a leak, the zoning dampers are driven fully open and additional mechanical ventilation is activated;
- 11) for mechanical ventilation as specified in GG.8.3 or for **enhanced tightness refrigerating systems** in GG.11.3, information on installation of the mechanical ventilation air extracted and air intake openings per GG.8.3.3 or for **enhanced tightness refrigerating systems** in GG.11.3.3;
- 12) for appliances relying on safety measures according to GG.8.3 or for **enhanced tightness refrigerating systems** according to GG.11.3, instructions for wiring to mechanical ventilation;
- 13) for appliances using a remote located **refrigerant sensor**, how and where to install and connect the **refrigerant sensor** in compliance with the requirements of 22.121.1, including how to verify correct installation by test;
- 14) when a remote located **refrigerant sensor** is specified by the manufacturer, the instructions shall state the recommended periodic service and maintenance procedures;
- 15) when a **limited life refrigerant sensor** is employed, the life of the **refrigerant sensor** and instruction on how to replace it;
- 16) for appliances using **A2L refrigerants**, connected via an air duct system to one or more rooms, the supply and return air shall be directly ducted to the space. Open areas such as false ceilings shall not be used as a return air duct;
- 17) a warning that precautions shall be taken to avoid excessive vibration or pulsation to refrigerating piping;
- 18) a warning that protection devices, piping and fittings shall be protected as far as possible against adverse environmental effects, for example the danger of water collecting and freezing in relief pipes or the accumulation of dirt and debris;
- 19) a warning that provision shall be made for expansion and contraction of long runs of piping;

- 20) a warning that piping in refrigerating systems shall be so designed and installed as to minimize the likelihood of hydraulic shock damaging the system;
- 21) a warning that solenoid valves shall be correctly positioned in the piping to avoid hydraulic shock and shall not block in liquid refrigerant unless adequate relief is provided;
- 22) a warning that steel pipes and components shall be protected against corrosion with a rustproof coating before applying any insulation;
- 23) where field installed **safety shut-off valves** are specified for refrigerating systems, a warning that only **safety shut-off valves** specified by the appliance manufacturer shall be used;
- 24) where **safety shut-off valves** are to be field installed, information on where and how the **safety shut-off valves** shall be installed;
- 25) information that **safety shut-off valves** shall only be replaced with valves specified by the appliance manufacturer;
- 26) field-made refrigerant joints indoors shall be tightness tested. The test method shall have a sensitivity of 5 grams per year of refrigerant or better under a pressure of at least 0,25 times the **maximum allowable pressure**. No leak shall be detected;
- 27) where remote **refrigerant detection systems** are specified, a warning that only **refrigerant sensors** specified by the appliance manufacturer may be used;
- 28) information that the **refrigerant detection system refrigerant sensors** shall only be replaced with **refrigerant sensors** specified by the appliance manufacturer;
- 29) for appliances with a **leak detection system**, **safety shut-off valves** shall not be reset until the room has been ventilated, because resetting can result in additional **flammable refrigerant** released into the space;
- 30) electrical components that can arc or spark, which are not considered ignition sources due to compliance with 22.116.1 points b), c), d), or f) shall only be replaced with parts specified by the appliance manufacturer. Replacement with other parts can result in the ignition of refrigerant in the event of a leak;
- 31) where openings according to GG.1.4 are applied, information that these openings shall not be blocked.

DD.3.2 Unventilated areas

For appliances containing more than m_1 for any refrigerating circuit, the instructions shall include a statement advising that an unventilated area where the appliance is installed shall be so constructed that should any refrigerant leak, it will not stagnate so as to create a fire or explosion hazard. This shall include:

- for appliances which are not **fixed appliances**, a warning that the **appliance** shall be stored in an area where the room size corresponds to the room area as specified for operation;
- for appliances which are not **fixed appliances**, a warning that the **appliance** shall be stored in a room without continuously operating open flames (for example an operating gas appliance) or other potential ignition sources (for example an operating electric heater, hot surfaces);
- a warning that if appliances connected via an air duct system to one or more rooms are installed in a room with an area less than A_{min} as determined in Clause GG.2, that room shall be without continuously operating open flames (for example an operating gas appliance) or other potential ignition sources (for example an operating electric heater, hot surfaces). A flame-producing device may be installed in the same space if the device is provided with an effective flame arrestor;
- for appliances connected via an air duct system to one or more rooms, a warning with the substance of the following: "Auxiliary devices which can be a potential ignition source shall not be installed in the ductwork. Examples of such potential ignition sources are hot surfaces with a temperature exceeding X °C and electric switching devices";

NOTE X is the maximum allowable surface temperature as defined in 22.117.

- for appliances connected via an air duct system to one or more rooms, a warning that only auxiliary devices approved by the appliance manufacturer or declared suitable with the refrigerant shall be installed in the connecting ductwork. The manufacturer can list in the instructions all approved auxiliary devices by the manufacturer and model number for use with the specific appliance.

The manufacturer should specify other potential continuously operating sources known to cause ignition of the refrigerant used.

The appliance shall be stored so as to prevent mechanical damage from occurring.

DD.3.3 Qualification of workers

The instructions shall contain specific information about the required qualification of the working personnel for maintenance, service and repair operations. Every working procedure that affects safety means shall only be carried out by competent persons.

NOTE Information about competence of service personnel is given in informative Annex HH.

Examples for such working procedures are:

- breaking into the refrigerating circuit;
- opening of sealed components;
- opening of ventilated enclosures.

DD.4 Information on servicing

DD.4.1 General

The instructions shall contain specific information for service personnel according to DD.4.2 to DD.4.10.

DD.4.2 Checks to the area

Prior to beginning work on systems containing **flammable refrigerants**, safety checks are necessary to ensure that the risk of ignition is minimised. For repair to the **refrigerating system**, DD.4.3 to DD.4.7 shall be completed prior to conducting work on the system.

DD.4.3 Work procedure

Work shall be undertaken under a controlled procedure so as to minimise the risk of a flammable gas or vapour being present while the work is being performed.

DD.4.4 General work area

All maintenance staff and others working in the local area shall be instructed on the nature of work being carried out. Work in confined spaces shall be avoided.

DD.4.5 Checking for presence of refrigerant

The area shall be checked with an appropriate refrigerant detector prior to and during work, to ensure the technician is aware of potentially toxic or flammable atmospheres. Ensure that the leak detection equipment being used is suitable for use with all applicable refrigerants, i.e. non-sparking, adequately sealed or intrinsically safe.

DD.4.6 Presence of fire extinguisher

If any hot work is to be conducted on the refrigerating equipment or any associated parts, appropriate fire extinguishing equipment shall be available to hand. Have a dry powder or CO₂ fire extinguisher adjacent to the charging area.

DD.4.7 No ignition sources

No person carrying out work in relation to a **refrigerating system** which involves exposing any pipe work shall use any sources of ignition in such a manner that it can lead to the risk of fire or explosion. All possible ignition sources, including cigarette smoking, should be kept sufficiently far away from the site of installation, repairing, removing and disposal, during which refrigerant can possibly be released to the surrounding space. Prior to work taking place, the area around the equipment is to be surveyed to make sure that there are no flammable hazards or ignition risks. "No smoking" signs shall be displayed.

DD.4.8 Ventilated area

Ensure that the area is in the open or that it is adequately ventilated before breaking into the system or conducting any hot work. A degree of ventilation shall continue during the period that the work is carried out. The ventilation should safely disperse any released refrigerant and preferably expel it externally into the atmosphere.

DD.4.9 Checks to the refrigerating equipment

Where electrical components are being changed, they shall be fit for the purpose and to the correct specification. At all times the manufacturer's maintenance and service guidelines shall be followed. If in doubt, consult the manufacturer's technical department for assistance.

*The following checks shall be applied to installations using **flammable refrigerants**:*

- *the **refrigerant charge** is in accordance with the room size within which the refrigerant containing parts are installed;*
- *the ventilation machinery and outlets are operating adequately and are not obstructed;*
- *if an indirect refrigerating circuit is being used, the secondary circuit shall be checked for the presence of refrigerant;*
- *marking to the equipment continues to be visible and legible. Markings and signs that are illegible shall be corrected;*
- *refrigerating pipe or components are installed in a position where they are unlikely to be exposed to any substance which can corrode refrigerant containing components, unless the components are constructed of materials which are inherently resistant to being corroded or are suitably protected against being so corroded.*

DD.4.10 Checks to electrical devices

Repair and maintenance of electrical components shall include initial safety checks and component inspection procedures. If a fault exists that could compromise safety, then no electrical supply shall be connected to the circuit until it is satisfactorily dealt with. If the fault cannot be corrected immediately but it is necessary to continue operation, an adequate temporary solution shall be used. This shall be reported to the owner of the equipment so all parties are advised.

Initial safety checks shall include:

- that capacitors are discharged: this shall be done in a safe manner to avoid possibility of sparking;
- that no live electrical components and wiring are exposed while charging, recovering or purging the system;
- that there is continuity of earth bonding.

DD.5 Sealed electrical components

Sealed electrical components shall not be repaired.

DD.6 Cabling

Check that cabling will not be subject to wear, corrosion, excessive pressure, vibration, sharp edges or any other adverse environmental effects. The check shall also take into account the effects of ageing or continual vibration from sources such as compressors or fans.

DD.7 Detection of flammable refrigerants

Under no circumstances shall potential sources of ignition be used in the searching for or detection of refrigerant leaks. A halide torch (or any other detector using a naked flame) shall not be used.

The following leak detection methods are deemed acceptable for all refrigerant systems.

Electronic leak detectors may be used to detect refrigerant leaks but, in the case of **flammable refrigerants**, the sensitivity can be inadequate or can require re-calibration. (Detection equipment shall be calibrated in a refrigerant-free area.) Ensure that the detector is not a potential source of ignition and is suitable for the refrigerant used. Leak detection equipment shall be set at a percentage of the **LFL** of the refrigerant and shall be calibrated to the refrigerant employed, and the appropriate percentage of gas (25 % maximum) is confirmed.

Leak detection fluids are also suitable for use with most refrigerants but the use of detergents containing chlorine shall be avoided as the chlorine can react with the refrigerant and corrode the copper pipe-work.

NOTE Examples of leak detection methods are

- bubble method,
- fluorescent agent method.

If a leak is suspected, all naked flames shall be removed/extinguished.

If a leakage of refrigerant is found which requires brazing, all of the refrigerant shall be recovered from the system, or isolated (by means of shut-off valves) in a part of the system remote from the leak. Removal of refrigerant shall be according to Clause DD.8.

DD.8 Refrigerant removal and circuit evacuation

When breaking into the refrigerant circuit to make repairs – or for any other purpose – conventional procedures shall be used. However, for **flammable refrigerants** it is important that best practice is followed since flammability is a consideration. The following procedure shall be adhered to:

- safely remove refrigerant. Local and national regulations can apply;
- evacuate;
- purge the circuit with inert gas (optional for A2L);
- evacuate (optional for A2L);
- continuously flush with inert gas when using flame to open circuit;
- open the circuit.

The **refrigerant charge** shall be recovered into the correct recovery cylinders.

The manufacturer shall specify the inert gases that can be used. Compressed air or oxygen shall not be used for purging refrigerant systems.

NOTE An example of an inert gas is dry nitrogen.

Purging of the refrigerant circuit shall be achieved by breaking the vacuum in the system with inert gas and continuing to fill until the working pressure is achieved, then releasing to atmosphere, and finally pulling down to a vacuum. This process shall be repeated until no refrigerant is within the system. The system shall be vented down to atmospheric pressure to enable work to take place.

Ensure that the outlet of the vacuum pump is not close to any potential ignition sources and that ventilation is available.

DD.9 Charging procedures

In addition to conventional charging procedures, the following requirements shall be followed.

- Ensure that contamination of different refrigerants does not occur when using charging equipment. Hoses or lines shall be as short as possible to minimise the amount of refrigerant contained in them.
- Cylinders shall be kept in an appropriate position according to the instructions.
- Ensure that the **refrigerating system** is earthed prior to charging the system with refrigerant.
- Label the system when charging is complete (if not already labelled).
- Extreme care shall be taken not to overfill the **refrigerating system**.

Prior to recharging the system, it shall be pressure-tested with the appropriate purging gas. The system shall be leak-tested on completion of charging but prior to commissioning. A follow up leak test shall be carried out prior to leaving the site.

DD.10 Decommissioning

Before carrying out this procedure, it is essential that the technician is completely familiar with the equipment and all its detail. It is recommended good practice that all refrigerants are recovered safely. Prior to the task being carried out, an oil and refrigerant sample shall be taken in case analysis is required prior to re-use of the recovered refrigerant. It is essential that electrical power is available before the task is commenced.

- 1) Become familiar with the equipment and its operation.

- 2) Isolate the system electrically.
- 3) Before attempting the procedure, ensure that:
 - a) mechanical handling equipment is available, if required, for handling refrigerant cylinders;
 - b) all personal protective equipment is available and being used correctly;
 - c) the recovery process is supervised at all times by a competent person;
 - d) recovery equipment and cylinders conform to the appropriate standards.
- 4) Pump down the refrigerant system, if possible.
- 5) If a vacuum is not possible, make a manifold so that refrigerant can be removed from various parts of the system.
- 6) Make sure that the cylinder is situated on the scales before recovery takes place.
- 7) Start the recovery machine and operate in accordance with instructions.
- 8) Do not overfill cylinders (no more than 80 % volume liquid charge).
- 9) Do not exceed the maximum working pressure of the cylinder, even temporarily.
- 10) When the cylinders have been filled correctly and the process completed, make sure that the cylinders and the equipment are removed from site promptly and all isolation valves on the equipment are closed off.
- 11) The recovered refrigerant shall not be charged into another **refrigerating system** unless it has been cleaned and checked.

DD.11 Labelling

Equipment shall be labelled stating that it has been decommissioned and emptied of refrigerant. The label shall be dated and signed. For appliances containing **flammable refrigerants**, ensure that there are labels on the equipment stating the equipment contains **flammable refrigerant**.

DD.12 Recovery

When removing refrigerant from a system, either for servicing or decommissioning, it is required to follow good practice so that all refrigerants are removed safely.

When transferring refrigerant into cylinders, ensure that only appropriate refrigerant recovery cylinders are employed. Ensure that the correct number of cylinders for holding the total system charge is available. All cylinders to be used are designated for the recovered refrigerant and labelled for that refrigerant (i.e. special cylinders for the recovery of refrigerant). Cylinders shall be complete with pressure-relief valve and associated shut-off valves in good working order. Empty recovery cylinders are evacuated and, if possible, cooled before recovery occurs.

The recovery equipment shall be in good working order with a set of instructions concerning the equipment that is at hand and shall be suitable for the recovery of the **flammable refrigerant**. Consult manufacturer if in doubt. In addition, a set of calibrated weighing scales shall be available and in good working order. Hoses shall be complete with leak-free disconnect couplings and in good condition.

The recovered refrigerant shall be processed in the correct recovery cylinder, and the relevant waste transfer note arranged. Local legislation can apply. Do not mix refrigerants in recovery units and especially not in cylinders.

If compressors or compressor oils are to be removed, ensure that they have been evacuated to an acceptable level to make certain that **flammable refrigerant** does not remain within the lubricant. The compressor body shall not be heated by an open flame or other ignition sources to accelerate this process. Draining of oil from a system shall be carried out safely.

Annex EE (normative)

Pressure tests

EE.1 General

All **refrigerating system** parts shall withstand the maximum pressure in **normal operation**, abnormal operation, and standstill.

The **maximum allowable pressure** marked on the system shall be not less than the maximum pressure developed during operation under Clause 11, under Clause 19 and during standstill (see Clause EE.2).

It is not necessary for a compressor tested and found to comply with IEC 60335-2-34 to be additionally tested.

Compliance is checked by the tests in Clause EE.3 or Clause EE.4.

*All tested samples shall not leak. Where gaskets are employed for sealing parts under pressure, leakage at gaskets is acceptable, provided the leakage only occurs at a value greater than 120 % of the **maximum allowable pressure** and the test pressure is still reached for the specified time. Additional sealing measures, such as an "O" ring, for pressure testing may be provided.*

It is not necessary for pressure gauges and control mechanisms to be subjected to the test, provided the parts meet the requirements of the component.

EE.2 Determination of standstill pressure

In order to determine the standstill pressure, the appliance shall be soaked in the highest operating temperature specified by the manufacturer for 1 h with power off.

*A **refrigerating system** component that is exposed only to low side pressure can be exposed to a higher pressure under the condition of standstill than under **normal operation**.*

EE.3 Strength pressure test

*The test pressure shall be at least three times the marked **maximum allowable pressure**.*

The pressure test shall be carried out on three samples of each component. The test samples are filled with a liquid, such as water, to exclude air and are connected in a hydraulic pump system. The pressure is raised gradually until the required test pressure is reached. The pressure is maintained for at least 1 min.

EE.4 Fatigue test

*The components shall be subjected to a test at 2 times the marked **maximum allowable pressure**, provided the components comply with the fatigue test. This test is conducted on a separate sample.*

Three samples of each refrigerant-containing part shall be tested. The total number of cycles shall be 250 000.

The test samples shall be filled with fluid and shall be connected to a pressure-driving source. The pressure shall be raised and lowered between the upper and lower cyclic values at a rate specified by the manufacturer. The pressure shall reach the specified upper and lower values during each cycle. The shape of the pressure cycle shall be such that the upper and lower pressure values shall be maintained for at least 0,1 s.

NOTE 1 For safety purposes, a non-compressible fluid can be used for the test. The fluid fills the sample completely to prevent any significant remaining gas.

If the operating temperatures of the appliance under the conditions of steady state operation of Clause 11 are less than or equal to 125 °C for copper or aluminium, or 200 °C for steel, the test temperature of the component part or assembly shall be at least 20 °C. If the continuous operating temperature of the component exceeds 125 °C for copper or aluminium, or 200 °C for steel, the test temperature of the parts or assemblies that are at these temperatures, and subjected to the pressure, shall be at least 25 K greater than the temperature of the part measured during the test of Clause 11 for copper or aluminium and 60 K higher for steel. For other materials, the effects of temperature on the material fatigue characteristics shall be evaluated by conducting the test at the higher temperatures and considering the material characteristics at the higher temperatures.

*The pressure for the first cycle shall be the marked **maximum allowable pressure**.*

The pressure for the test cycles shall be as follows:

- a) *For components subject to high side pressures, the upper pressure value shall not be less than the saturated vapour pressure of the refrigerant at 50 °C and the lower pressure value shall not be greater than the saturated vapour pressure of the refrigerant at 5 °C. For **sanitary hot water heat pumps**, the upper pressure shall not be less than 80 % of the marked **maximum allowable pressure** under the conditions of Clause 11.*
- b) *For components subjected to only low side pressures, the upper pressure value shall not be less than the saturated vapour pressure of the refrigerant at 30 °C and the lower pressure value shall be between 0 bar and the greater of 4,0 bar or the saturated vapour pressure of the refrigerant at –13 °C.*

NOTE 2 The objective is to avoid a test value that is a negative pressure but to require a lower pressure value of the saturated vapour pressure at –13 °C or 4,0 bar, whichever is greater.

For the final test cycle, the test pressure shall be to two times the pressure determined in a) or b).

Annex FF (normative)

Leak simulation tests

FF.1 General

A leakage of refrigerant is simulated in the **refrigerating system** at the **potential leak points**. The method to simulate a leakage at the **potential leak points** is to inject refrigerant vapour through a suitable capillary tube at that point. Where **LFL** is referenced in this annex, the **LFL** shall be taken at the nominal composition as specified in Annex BB.

Piping are not considered to be **potential leak points** within the area of the appliance to be evaluated if they comply with all of the following:

- are protected from potential damage during **normal operation**, service and maintenance;
- have no connecting joints;
- have no bends with centreline bend radius less than 2,5 times the external pipe diameter.

FF.2 Test methods

FF.2.1 The appliance is modified by introducing a simulated leak through a capillary tube.

The quantity of refrigerant leaked, m_{FF} , is equal to the smallest of:

- the **refrigerant charge**, m_C ;
- the **releasable charge**, m_{rl} , as determined by Annex QQ;
- for parts of **enhanced tightness refrigerating systems** which can leak into an indoor space using **A2L refrigerant**, 10 kg;
- for parts of **enhanced tightness refrigerating systems** which can leak into an indoor space using A2 or A3, the amount that will leak during 1 h with the leak rate $\dot{m}_{leak}$ of GG.14.3.

The leak rate shall be maintained at 25 % $\pm$ 5 % of the refrigerant leaked, m_{FF} , per minute.

For parts of **enhanced tightness refrigerating systems** which can leak into an indoor space, the leak rate shall be maintained at 10 kg per hour for **A2L refrigerants** or the leak rate $\dot{m}_{leak}$ of GG.14.3 for A2 and A3 refrigerants.

The leak shall be maintained until the quantity of refrigerant leaked, m_{FF} , has leaked.

The refrigerant is injected at the most unfavourable **potential leak point** and the most unfavourable direction at ambient temperature (15 °C to 35 °C).

FF.2.2 During this test, the appliance is switched off or operated under **normal operation** at **rated voltage**. If airflow is activated before any potential ignition sources are activated, then the test is not conducted with the appliance switched off. During a test where the appliance is operating, refrigerant gas injection is started at the same time as the appliance is switched on.

In "switched off" mode, the appliance shall remain connected to the mains and safety mitigation controls, such as **refrigerant detection system** and **circulation airflow** or **safety shut-off valves**, shall be allowed to function as intended.

FF.2.3 For refrigerant blends, the test shall be carried out using the nominal composition as defined in Annex BB.

If a zeotropic blend is used, the test is conducted maintaining the composition within a reasonable range. It is acceptable to use liquid phase of the blend extracted from the bottle then evaporated. Gas phase release with the pressure regulator from a large mixed gas tank is the best method, but care shall be taken to avoid any condensation occurring in the vessel.

FF.2.4 The test is conducted in a room that is draught-free and of sufficient size to conduct the test.

The minimum volume (V) is:

$$V = (15 \times m_{FF}) / LFL \quad (FF.1)$$

where

V is the minimum volume in m^3 with a ceiling height not less than 2,2 m;

m_{FF} is the quantity of refrigerant leaked as defined in FF.2.1 in kg;

LFL is the **lower flammability** limit in kg/m^3 .

The quantity of gas injected shall be measured with acceptable accuracy. Weighing the bottle is required.

Care shall be taken that the installation of the capillary tube does not unduly influence the results of the test and that the structure of the appliance does not unduly influence the results of the test.

The instrument used for monitoring the refrigerant gas concentration shall have a $t(90)$ response time of faster than 30 s and shall be located so as to not unduly influence the results of the test.

If gas chromatography is used to measure the refrigerant gas concentrations, the gas sampling in confined areas shall not exceed 2 ml every 30 s.

FF.2.5 The measured concentration of refrigerant gas surrounding any component that can be an ignition source shall not exceed 25 % of the **LFL** of the refrigerant gas, and shall not exceed 15 % of the **LFL** of the refrigerant gas for a time period of 5 min during and after the amount has been injected.

Annex GG (normative)

Charge limits, ventilation requirements and requirements for secondary circuits

GG.1 Requirements for refrigerant charge limits

GG.1.1 General

When a **flammable refrigerant** is used, the requirements for the installation space of the appliance and/or ventilation requirements are determined according to

- the **refrigerant charge** (m_c) used in the appliance,
- the **releasable charge** (m_{rl}),
- the installation location,
- the type of ventilation of the location or of the appliance.

For appliances with multiple **refrigerating systems**, each **refrigerating system** shall be evaluated independently.

Where multiple values of A_{min} are found based on different **operating states**, the highest value shall be A_{min} for the appliance.

NOTE 1 This can be the case when different measures are used under different **operating states**, for example when continuous airflow is applied during an active operation state, and **releasable charge** is applied during standstill.

Where the parameters **lower flammability limit (LFL)** and molecular weight (M) are referenced in Annex GG, the values used shall be based on worst case formulation (WCF) as specified in Annex BB.

Toxicity charge limits shall be determined in accordance with ISO 5149-1:2014, ISO 5149-1:2014/AMD1:2015, and ISO 5149-1:2014/AMD2:2021. If the toxicity-based charge limits are less than the flammability-based charge limits, the toxicity charge limits shall take precedence.

For appliances with a **refrigerant charge** of $m_c \leq m_1$, no minimum room area is required and Clause GG.6 does not apply.

For appliances where leaked refrigerant does not enter the indoor space, no minimum room area is required.

If **releasable charge** is determined by Annex QQ:

- for **releasable charge** $m_{rl} \leq m_1$, there is no requirement for minimum room area, A_{min} , and Clause GG.6 does not apply;
- for **releasable charge** $m_{rl} > m_1$, each **operating state** of the **refrigerating system** shall comply with at least one of the following clauses: GG.2, GG.3, GG.4, GG.7, GG.9, and GG.14. The **refrigerant charge** m_c shall be replaced by the **releasable charge** m_{rl} in the formulae of Annex GG.

NOTE 2 Table GG.1 is provided as guidance when applying Annex GG. The column for indoor or outdoor application is determined. The requirements are identified in the appropriate box where the product and installation requirements are identified.

NOTE 3 The requirements applicable to a higher **refrigerant charge** can be applied for each range in Table GG.1.

Table GG.1 – Outline of Annex GG

Refrigerant charge	Direct system ^a				Indirect system ^b
	Indoor space			Outdoors	
	Refrigerant charge and room area	Refrigerant charge, room area and additional requirements	Additional ventilation		
$m_c \leq m_1$ or $m_{rl} \leq m_1$	No room size restriction			No room size restriction	No room size restriction, Clause GG.6
$m_1 < m_c \leq 2 \times m_1$ (appliances which are not fixed appliances)	Not allowed	Clause GG.7	Not allowed		
$m_1 < m_c \leq m_2$	GG.2.1	GG.2.2 ^c , GG.2.3 ^d , Clause GG.9 ^c , Clause GG.10 ^c , Clause GG.14 ^d	Clause GG.3, Clause GG.8 ^c , Clause GG.10 ^c		
$m_2 < m_c \leq m_3$	Not allowed	Clause GG.9 ^c , Clause GG.10 ^c	Clause GG.3, Clause GG.8 ^c , Clause GG.10 ^c		
$m_c > m_3$	Beyond the scope of this standard. National standards apply.				

^a Direct system means a **refrigerating system** in which a single rupture of the refrigerant circuit results in a refrigerant release to an indoor space, irrespective of the location of the refrigerant circuit.

^b Indirect system means a **refrigerating system** in which a single rupture of the refrigerant circuit does not leak into an indoor space, irrespective of the location of the refrigerant circuit.

^c These clauses are only applicable to appliances with **A2L refrigerant**.

^d These clauses are only applicable to appliances with A2 or A3 refrigerant.

GG.1.2 Determination of the refrigerant capped quantity limit

For A2 and A3 refrigerants, m_1 , m_2 , m_3 are defined as follows:

$$m_1 = 4 \times LFL \quad (GG.1)$$

$$m_2 = 26 \times LFL \quad (GG.2)$$

$$m_3 = 130 \times LFL \quad (GG.3)$$

where LFL is the **lower flammability limit** in kg/m³ for the refrigerant used.

For **A2L refrigerants**, m_1 , m_2 , m_3 are defined as follows:

$$m_1 = 6 \times LFL \quad (GG.4)$$

$$m_2 = 52 \times LFL \quad (GG.5)$$

$$m_3 = 260 \times LFL \quad (\text{GG.6})$$

where LFL is the **lower flammable limit** in kg/m³ for the refrigerant used.

NOTE The factors in the formulae are in m³.

GG.1.3 Determination of unventilated room area

GG.1.3.1 General

For the purpose of determination of room area (A) when used to calculate the **maximum refrigerant charge** ($m_{\max}$) in an unventilated space, the following shall apply.

The room area (A) shall be defined as the room area enclosed by the projection to the floor of the walls, partitions and doors of the space in which the appliance is installed.

Spaces connected by only drop ceilings, ductwork, or similar connections shall not be considered a single space.

GG.1.3.2 Determination of unventilated room area for appliances using A2L refrigerant

For units mounted higher than 1,6 m, and in compliance with GG.2.2, spaces divided by partition walls which are no higher than 1,6 m shall be considered a single space.

For **fixed appliances**, rooms on the same floor and connected by an open passageway between the spaces can be considered a single room when determining compliance to $A_{\min}$, if the passageway complies with all of the following:

- it is a permanent opening;
- it extends to the floor;
- it is intended for people to walk through.

For **fixed appliances**, the area of the adjacent rooms, on the same floor, connected by permanent opening in the walls and/or doors between occupied spaces, including gaps between the wall and the floor, can be considered a single room when determining compliance to $A_{\min}$, provided all of the following are met.

- The space shall have appropriate openings according to GG.1.4.
- The minimum opening area for natural ventilation, $A_{nv,\min}$, shall not be less than the following:

$$A_{nv,\min} = \frac{m_c - m_{\max}}{LFL \times 104} \times \sqrt{\frac{A}{g \times m_{\max}} \times \frac{M}{M - 29}} \quad (\text{GG.7})$$

where

- $A_{nv,\min}$ is the minimum opening for natural ventilation in m²;
- m_c is the actual **refrigerant charge** of refrigerant in the system in kg;
- $m_{\max}$ is the allowable **maximum refrigerant charge** in the system in kg, calculated according to Formula (GG.8) or m_2 , whichever is lower;
- LFL is the **lower flammability limit** in kg/m³;
- A is the room area in m²;

M	is the molar mass of the refrigerant in kg/kmol;
g	is the gravity acceleration of 9,81 m/s ² ;
29	is the average molar mass of air in kg/kmol;
104	is a constant.

GG.1.3.3 Determination of unventilated room area for appliances using A2 and A3 refrigerant

For determining compliance to $A_{\min}$ for **fixed appliances** with release height, h_0 , according to GG.2.1, not less than 1,6 m, rooms on the same floor and connected by an open passageway between the spaces can be considered a single room if the passageway complies with all of the following:

- it is a permanent opening;
- it extends to the floor;
- it is intended for people to walk through.

For determining compliance to $A_{\min}$ for **fixed appliances** and with release height, h_0 , according to GG.2.1, less than 1,6 m or **fixed appliances** with **circulation airflow** at any release height, h_0 , rooms on the same floor and connected by an open passageway between the spaces can be considered a single room with an area of the space that the refrigerant can leak directly into plus half of the area of the connected space, if all of the following is complied with:

- the area of the space in which the unit is installed shall not be less than 20 % of $A_{\min}$;
- the passageway is a permanent opening;
- the passageway extends to the floor;
- the passageway is intended for people to walk through.

GG.1.4 Opening conditions for connected rooms and natural ventilation for appliances using A2L refrigerants

When the openings for connected rooms or natural ventilation are required, the following conditions shall be applied for the lower opening.

- The area of any openings above 300 mm from the floor shall not be considered in determining compliance with $A_{nv,\min}$.
- At least 50 % of the required opening area $A_{nv,\min}$ shall be below 200 mm from the floor.
- The bottom of the lowest openings shall not be higher than the point of release when the unit is installed and not more than 100 mm from the floor.
- For openings extending to the floor, the height shall not be less than 20 mm above the surface of the floor covering.

A second higher opening shall be provided. The total size of the second opening shall not be less than 50 % of minimum opening area for $A_{nv,\min}$ and shall be at least 1,5 m above the floor.

Openings shall be permanent openings which cannot be closed.

NOTE The requirement for the second opening can be met by drop ceilings, ventilation ducts, or similar arrangements that provide an airflow path between the connected rooms.

GG.2 Requirements for charge limits in unventilated areas

GG.2.1 General

Clause GG.2 is applicable for appliances with a **refrigerant charge** of $m_1 < m_c \leq m_2$ and for **factory sealed single package units** which are not **fixed appliances** with a **refrigerant charge** of $m_1 < m_c \leq 2 \times m_1$. See Figure GG.1.

For **factory sealed single package units** which are not **fixed appliances** with a **refrigerant charge** of $m_1 < m_c \leq 2 \times m_1$, the requirements of Clause GG.7 apply.

For systems using **A2L refrigerants** with a **refrigerant charge** of $m_1 < m_c \leq m_3$ that comply with the conditions in 22.125, the requirements of Clause GG.10 can apply.

For systems using A2 or A3 refrigerants with a **refrigerant charge** of $m_1 < m_c \leq m_2$ that comply with the conditions in 22.125, the requirements of Clause GG.14 can apply.

For other appliances with a **refrigerant charge** of $m_1 < m_c \leq m_2$:

The **maximum refrigerant charge** in a room shall be in accordance with the following:

$$m_{\max} = 2,5 \times (LFL)^{(5/4)} \times h_0 \times (A)^{1/2}, \text{ not to exceed } m_{\max} = CF \times LFL \times h_0 \times A \quad (\text{GG.8})$$

or the required minimum room area $A_{\min}$ to install an appliance with **refrigerant charge** m_c (kg) shall be in accordance with following:

$$A_{\min} = (m_c / (2,5 \times (LFL)^{(5/4)} \times h_0))^2, \text{ not less than } A_{\min} = m_c / (CF \times LFL \times h_0) \quad (\text{GG.9})$$

where

$m_{\max}$ is the allowable **maximum refrigerant charge** in a room, in kg;

m_c is the **refrigerant charge** in the appliance, in kg;

$A_{\min}$ is the required minimum room area, in m²;

A is the room area, in m²;

2,5 is a constant;

LFL is the **lower flammability limit**, in kg/m³;

CF is a concentration factor with a value of 0,75 for **refrigerating systems** using **A2L refrigerant** and a value of 0,5 for **refrigerating systems** using A2 or A3 refrigerant;

h_0 is the release height, the vertical distance in metres from the floor to the point of release when the appliance is installed (see Figure GG.3). $h_0 = (h_{\text{inst}} + h_{\text{rel}})$ or 0,6 m, whichever is higher.

h_{rel} is the **release offset** in metres from the bottom of the appliance to the point of release (see Figure GG.3). Cumulative openings smaller than 5 cm² and openings with a single dimension of not more than 0,1 mm are not considered as openings where leaking refrigerant can escape. Openings for routing of wires and tubing which are not sealed openings shall include the total area of the opening without consideration of the area occupied by the tubing or wire.

h_{inst} is the **installed height** in metres of the unit (see Figure GG.3).

Reference **installed heights** are given below:

$h_{\text{inst}} = 0,0$ m for portable and floor mounted;

$h_{\text{inst}} = 1,0$ m for window mounted;

$h_{\text{inst}} = 1,8$ m for wall mounted;

$h_{\text{inst}} = 2,2$ m for ceiling mounted.

If the minimum **installed height** given by the manufacturer is higher than the reference **installed height**, then in addition A_{min} and m_{max} for the reference **installed height** shall be given by the manufacturer. An appliance may have multiple reference **installed heights**. In this case, A_{min} and m_{max} calculations shall be provided for all applicable reference **installed heights**.

For appliances serving one or more rooms with an air duct system, the lowest opening of the duct connection to each conditioned space or any opening of the indoor unit greater than 5 cm^2 , at the lowest position to the space, shall be used for h_0 . However, h_0 shall not be less than $0,6$ m. A_{min} shall be calculated as a function of the opening heights of the duct to the spaces and the **refrigerant charge** for the spaces where leaked refrigerant can flow to, considering where the unit is located. A_{min} shall be calculated for the spaces where a duct is connected, or an indoor unit is located. If all spaces have room area not less than A_{min} , no further measure is required. If any room area of spaces is below A_{min} , measures according to Clause GG.8 or Clause GG.9 shall be provided for appliances using **A2L refrigerants**.

GG.2.2 Fixed appliances using A2L refrigerants with integral circulation airflow

GG.2.2.1 General

When the fan integrated into an appliance is continuously operated or operation is initiated by a **leak detection system** with a sufficient **circulation airflow** (see also Table GG.2), the **maximum refrigerant charge** can be increased, or minimum room area can be reduced according to the following:

The **maximum refrigerant charge** in a room shall be in accordance with the following:

$$m_{\text{max}} = CF \times LFL \times h_{\text{ra}} \times A \quad (\text{GG.10})$$

or the required minimum room area A_{min} of the installed appliance with **refrigerant charge** m_c (kg) shall be in accordance with the following:

$$A_{\text{min}} = m_c / (CF \times LFL \times h_{\text{ra}}) \quad (\text{GG.11})$$

where

CF is a concentration factor with a value of $0,75$;

m_{max} is the allowable **maximum refrigerant charge** in the system in kg;

m_c is the actual **refrigerant charge** in the system in kg;

A_{min} is the required minimum room area in m^2 ;

h_{ra} is the estimated reaching height of airflow (see Table GG.2) in m;

A is the room area in m²;

LFL is the **lower flammability limit** in kg/m³.

If the space has a room area not less than A_{min} , no further measure is required. If the room area of the space is below A_{min} , measures according to Clause GG.8 shall be applied.

Table GG.2 – Circulation airflow

Appliances	Airflow direction ϕ^c (°)	Airflow		Estimated reaching height h_{ra}^b (m)
		Minimum velocity ^a v (m/s)	Minimum airflow Q_{min} (m³/h)	
All	Downwards – 90° ≤ φ ≤ 0°	1	30 × m_c / LFL	h_a
Installed with lower edge of air inlet within 0,2 m from the floor	Upwards 0° < φ ≤ 90°			$h_a + h_d$

h_a is the height of the upper edge of the air discharge opening in m;

h_d is the dynamic reaching height of airflow in m.

^a Velocity shall be calculated as the airflow divided by the nominal face area of the outlet. The grille area shall not be deducted.

^b h_{ra} shall not exceed 2,2 m.

^c See Figure GG.4 for examples.

$$h_d = \left(1 + \frac{2,35}{LFL \left(1 - \frac{1,2}{\rho} \right) + 0,05} \right) \times (0,0183 \times v^2 \times \sin^2 \phi) \quad (GG.12)$$

where

v is the **circulation airflow** velocity in m/s;

ϕ is the **circulation airflow** elevation angle from horizontal in degrees ($0^\circ \leq \phi \leq 90^\circ$);

LFL is the **lower flammability limit** in kg/m³;

ρ is the gas density of the refrigerant at atmospheric pressure and 25 °C in kg/m³.

See Figure GG.4.

Compliance is checked by testing.

Operation of **circulation airflow** shall comply with either GG.2.2.2 or GG.2.2.3.

GG.2.2.2 Continuous circulation airflow

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below $Q_{\min}$, the following actions shall be taken:

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.2.2.3 Circulation airflow activated by a leak detection system

If a **leak detection system** is activated, the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the fan(s) of the appliance to deliver indoor airflow at or above the minimum airflow $Q_{\min}$;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.2.3 Fixed appliances using A2/A3 refrigerants with integral circulation airflow**GG.2.3.1 General**

When the fan integrated into an appliance is continuously operated or operation is initiated by a **leak detection system** with sufficient airflow rate, the **maximum refrigerant charge** can be increased or minimum room area can be reduced according to following.

The **maximum refrigerant charge** in a room shall be in accordance with the following:

$$m_{\max} = CF \times LFL \times A \times 2,2 \quad (\text{GG.13})$$

or the required minimum room area $A_{\min}$ of installed appliance with **refrigerant charge** m_c (kg) shall be in accordance with following:

$$A_{\min} = m_c / (CF \times LFL \times 2,2) \quad (\text{GG.14})$$

where

- $m_{\max}$ is the allowable **maximum refrigerant charge** in the system in kg;
- CF is a concentration factor specified by the manufacturer and not exceeding 0,5. CF shall be the same value as used in the formula for calculating $Q_{\min}$ in Formula (GG.15);
- m_c is the actual **refrigerant charge** in the system in kg;
- $A_{\min}$ is the required minimum room area in m^2 ;
- 2,2 is the room height in m;
- A is the room area in m^2 ;
- LFL is the **lower flammability limit** in kg/m^3 .

NOTE A lower value of CF can be specified to give a lower airflow requirement, and it results in a higher $A_{\min}$ and lower $m_{\max}$.

The fan integrated into an appliance shall have a minimum **circulation airflow** according to:

$$Q_{\min} = 3\,600 \frac{8Y\sqrt{A_o}}{240} \left(\frac{m_c}{LFL} \right)^{3/4} \left(\frac{CF^{1/4}}{1 - CF} \right) \quad (\text{GG.15})$$

where

- $Q_{\min}$ is the required airflow volume in m^3/h ;
- 3 600 is a constant to convert m^3/s to m^3/h ;
- 8 is a constant;
- A_o is the airflow discharge area of the appliance in m^2 . The value is the nominal face area of the outlet. The grille area shall not be deducted;
- 240 is a constant based on leaking the total **refrigerant charge** in 4 min;
- m_c is the actual **refrigerant charge** amount in the system in kg;
- LFL is the **lower flammability limit** in kg/m^3 ;
- Y is a constant, if there are leak sources outside the unit $Y = 1,5$, otherwise $Y = 1$;
- CF is a concentration factor specified by the manufacturer and not exceeding 0,5. The value shall be the value as used in Formula (GG.13) and Formula (GG.14) for calculating $m_{\max}$ and $A_{\min}$.

Compliance is checked by testing.

Operation of **circulation airflow** shall comply with either GG.2.3.2 or GG.2.3.3.

GG.2.3.2 Continuous circulation airflow

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below $Q_{\min}$, the following actions shall be taken:

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.2.3.3 Circulation airflow activated by a leak detection system

If a **leak detection system** is activated, the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the fan(s) of the appliance to deliver indoor airflow at or above the minimum airflow $Q_{\min}$;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.3 Requirements for charge limits in areas with mechanical ventilation

Clause GG.3 is applicable for appliances with a **refrigerant charge** of $m_1 < m_c \leq m_3$.

See Figure GG.2.

Mechanical ventilation applies to **fixed appliances** only.

Mechanical ventilation occurs when the appliance enclosure or the room is provided with a ventilating system that, in the event of a leak, is intended to vent refrigerant into an area where there is not a potential ignition source and the gas can be readily dispersed. The appliance enclosure shall have a ventilation system that produces airflow within the appliance enclosure and meets the requirements of Clause GG.4 or is intended to be installed in a room that meets the requirements of Clause GG.5.

GG.4 Requirements for mechanical ventilation within the appliance enclosure

The refrigerating circuit is provided with a separate enclosure that does not allow flow from inside the enclosure to the room. The appliance enclosure shall have a ventilation system that produces airflow from the appliance interior to the outside through an exhaust ventilation duct. The manufacturer shall specify the exhaust ventilation duct dimensions, the maximum length and number of bends. The negative pressure measurement in the interior of the appliance enclosure shall be 20 Pa or more and the flow rate to the exterior with open enclosure and attached maximum ventilation duct shall be at least $Q_{\min}$:

$$Q_{\min} = 3\,600 \times 1 / CF \times 24,5/M \times \dot{m}_{\text{leak}} \quad (\text{with a minimum of } 2 \text{ m}^3/\text{h}) \quad (\text{GG.16})$$

where

3 600 is a conversion of seconds to hours;

CF is a concentration factor with a value of 0,25;

M is the molar mass of refrigerant in kg/kmol;

$Q_{\min}$ is the minimum required volume flow of the ventilation in m^3/h ;

24,5 is the universal gas constant R multiplied by temperature of 298 K (25 °C) and divided by pressure of 101,325 kPa in l/mol;

$\dot{m}_{\text{leak}}$ is the leak rate in kg/s.

For **refrigerating systems** which are not **enhanced tightness refrigerating systems**, the leak rate, $\dot{m}_{\text{leak}}$, shall be determined as:

$$\dot{m}_{\text{leak}} = m_c / 240 \quad (\text{GG.17})$$

where

m_c is the **refrigerant charge** in kg;

240 is the 4 min release time in s.

For **enhanced tightness refrigerating systems**, the leak rate, $\dot{m}_{leak}$, shall be determined as:

- for **A2L refrigerants** $\dot{m}_{leak} = 0,002\ 78\ \text{kg/s}$,
- for A2 and A3 refrigerants, the values of GG.14.3.1, Table GG.6, in kg/s.

Ventilation shall be to the outside or to a room with a minimum volume as specified in Clause GG.2, Formula (GG.9).

The ventilation shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below Q_{min} , *the following actions shall be taken:*

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released into the enclosure.

Or:

The ventilation is switched on by a **leak detection system** and the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the fan(s) of the appliance to deliver airflow at or above the minimum airflow Q_{min} ;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the enclosure.

Compliance for the appliance ventilation system is checked by the following tests.

The appliance shall be installed in accordance with the instructions and the ventilation shaft shall not exceed the maximum length and number of bends specified by the manufacturer.

The room shall be at least 10 times the volume of the appliance and with sufficient make-up air to replace any air exhausted during the test. The air pressure differential is measured between the interior of the appliance enclosure and the room. The airflow rate shall be measured at the outside end of the ventilation shaft.

GG.5 Requirements for mechanical ventilation for rooms complying with ISO 5149-3

Machinery rooms shall meet the requirements of ISO 5149-3:2014, Clause 5 and ISO 5149-3:2014/AMD1:2021, 5.13, 5.14 and 5.15.

GG.6 Requirements for refrigerating systems employing secondary heat exchangers

If a **flammable refrigerant** is used and the system contains a secondary **heat exchanger**, the **heat exchanger** shall not allow the release of refrigerant into areas served by the secondary **heat exchanger** fluid. Compliance shall be met by at least one of the following:

- an open loop secondary system vented to the outside; or

- an automatic air/refrigerant separator and pressure relief valve is placed in the secondary circuit on the outlet pipe from the **evaporator** or the **condenser**. The air/refrigerant separator and pressure relief valve is at a high level relative to the outlet of the **heat exchanger** where leaked refrigerant can accumulate. The pressure relief valve shall have a flow rating rated to discharge the refrigerant that can be released through the **heat exchanger**. The air/refrigerant separator and pressure relief valve shall discharge the refrigerant into a space compliant with the charge limitations in Annex GG or to the outside; or
- a **double wall heat exchanger**, or
- a refrigerant system where the pressure of the secondary circuit is always greater than the pressure of the primary circuit in the area of contact, or
- the bursting of the secondary **heat exchanger** is avoided by

5) specifying requirements for specific properties of the secondary **heat exchanger** fluid to prevent corrosion, including:

- water: the manufacturer shall specify in the installation instructions the water quality necessary for the specified **heat exchanger**;
- brine: the manufacturer shall specify in the installation instructions the type of brine and its permitted concentration range for which the **heat exchanger** is suitable.

6) the use of a freezing protection device which considers:

- fluid freezing point;
- distribution through the **heat exchanger**;
- glide of the evaporating refrigerant;
- service procedures that could lead to freeze damage, for example adding or removing the refrigerant in liquid phase from a **heat exchanger** containing standing water.

*An appliance whose **heat exchangers** can be damaged as a result of freezing (e.g water to water **heat pumps**, water to air **heat pumps** or chillers) shall be tested as follows:*

- a) *The appliance shall be allowed to run under stable conditions. The volume flow through the **evaporator** shall be monitored.*
- b) *The circulation pump will be switched off.*
- c) *The freezing protection device shall switch off the compressor.*
- d) *After 1 min, the circulation pump will be switched on again and the compressor will restart.*
- e) *The procedures of items b) and d) shall be repeated 10 times.*
- f) *After 10 repetitions, the volume flow through the **evaporator** shall not be lower than the flow measured in item a). Measurement tolerance shall be taken into account.*
- g) *The appliance shall be tested with the minimum water flow at the **rated voltage** and frequency under the following temperature conditions.*

- *The water outlet is set just above the lowest cut out (taking into account tolerances) of the safety devices for protection against freezing of the **evaporator**.*
- *The **condenser** side is set so as to get the lowest condensation temperature within the **normal operation** range.*
- *The test equipment shall be set so that there is no automatic adjustment of the water flow on the **evaporator** side.*
- *The appliance shall operate continuously for a period of 6 h. During 6 h, none of the following conditions, indicating the start of freezing, shall appear:*

- 1) *the water flow on the **evaporator** side will not drop more than 5 % compared to the initial water flow;*
- 2) *the evaporating temperature will not drop more than 2 K;*

3) *the temperature difference between inlet and outlet water temperature of the **evaporator** will not drop more than 30 % compared to the initial temperature difference.*

h) The appliance shall then be tested with a maximum water flow under the conditions described in item g).

GG.7 Factory sealed single package units which are not fixed appliances with a refrigerant charge of $m_1 < m_c \leq 2 \times m_1$

GG.7.1 Determination of refrigerant charge

For **factory sealed single package units** which are not **fixed appliances** (i.e. one functional unit in one enclosure) with a **refrigerant charge** of $m_1 < m_c \leq 2 \times m_1$, the **maximum refrigerant charge** in a room shall be in accordance with the following:

$$m_{\max} = CF \times A \times LFL \times 2,2 \quad (\text{GG.18})$$

or the required minimum room area, $A_{\min}$, to install an appliance with **refrigerant charge** m_c shall be in accordance with the following:

$$A_{\min} = m_c / (CF \times LFL \times 2,2) \quad (\text{GG.19})$$

where

CF is a concentration factor with a value of 0,25;

$m_{\max}$ is the allowable **maximum refrigerant charge** in a room in kg;

m_c is the **refrigerant charge** in the appliance in kg;

$A_{\min}$ is the required minimum room area in m^2 ;

A is the room area in m^2 ;

LFL is the **lower flammability limit** in kg/m^3 ;

2,2 is the *minimum ceiling height employed in metres (m)*.

The appliance can be placed at any height above the floor.

When the appliance is switched on, a fan shall operate continuously supplying a minimum airflow as under normal steady state conditions, even when the compressor is switched off by the **thermostat**.

Compliance is checked by inspection.

GG.7.2 Mechanical requirements

GG.7.2.1 General

The appliance shall withstand the effects of dropping and vibration during transport and normal use without leaking refrigerant.

The appliance is subjected to the tests of GG.7.2.2 to GG.7.2.4. There shall be no refrigerant leakage.

Compliance is checked by the following:

The use of detection equipment having an equivalent sensitivity of 3 g/year of refrigerant shall reveal no leaks.

The tests of GG.7.2.2, GG.7.2.3 and GG.7.2.4 may be carried out on the appliance charged with a non-flammable refrigerant or a non-hazardous gas.

Damage of parts other than the refrigerating circuit is allowed.

GG.7.2.2 Drop test with packaging

The appliance is tested in its final packaging for transport and shall withstand the following number of drops on a horizontal hardwood board 20 mm thick placed on a concrete or similar hard surface:

- one with the appliance held upright;
- one for each of the four edges of the bottom side, with the bottom side forming an angle of about 30° to the horizontal.

The drop height depends on the weight of the appliance according to Table GG.3:

Table GG.3 – Appliance with packaging

Appliance weight kg	Drop height cm
< 10	80
≥ 10 and < 20	60
≥ 20 and < 30	50
≥ 30 and < 40	40
≥ 40 and < 50	30
≥ 50	20

GG.7.2.3 Drop test without packaging

The tests of GG.7.2.3 are repeated on the appliance without its packaging and with the drop height according to Table GG.4:

Table GG.4 – Appliance without packaging

Appliance weight kg	Drop height cm
< 10	20
≥ 10 and < 20	17
≥ 20 and < 30	15
≥ 30 and < 40	12
≥ 40	10

GG.7.2.4 Test after installation

The appliance is installed in accordance with the installation instructions. It is supplied at **rated voltage** or at the upper limit of the **rated voltage range** and operated at ambient temperature.

The appliance is operated for 960 cycles, each cycle consisting of the compressor running for 10 min minimum followed by a rest period of 5 min minimum.

This test may be made on a separate sample.

GG.7.3 Vibration test

Vibrations exceeding 0,30 G RMS, when measured with a low pass filter at 200 Hz, are not allowed in the refrigerant containing pipes under **normal operation**.

Compliance is checked by the following test:

The appliance is installed in accordance with the installation instructions. It is supplied at rated voltage or at the upper limit of the rated voltage range and operated at ambient temperature. The equipment shall be positioned in accordance with the manufacturer's instruction. Testing shall be conducted in fan only mode, and the heating and cooling mode if applicable.

*Vibration level shall be measured over the full range, +5 % of the maximum speed and –5 % of the minimum speed, of the compressor and indoor fan speeds as allowed by the controls at +10 % and –10 % input frequency, in consideration of the operation modes. For compressors and fans with discrete steps in speed, the vibration shall be measured at each step, +10 % and –10 %. If the equipment trips on a **protective device**, the maximum speed and frequency may be reduced until the equipment stays on line as intended. Care shall be taken that the measurement sensors do not influence the line vibration level, and that the rate of change of speed is sufficiently slow that the maximum vibration is captured.*

The vibration is measured at critical points in the piping.

NOTE Critical points are those with a larger vibration amplitude.

This test may be made on a separate sample.

GG.8 Ventilated area requirements for appliances using A2L refrigerants

GG.8.1 General

Clause GG.8 is applicable for appliances with a **refrigerant charge** of $m_1 < m_c \leq m_3$.

Ventilation according to GG.8.2 or GG.8.3 shall be provided when **refrigerant charge** is $m_c > m_{\max}$.

Natural and mechanical ventilation apply to **fixed appliances** only.

GG.8.2 Natural ventilation to outdoors

NOTE 1 Requirements for natural ventilation to the indoors can be found in GG.1.3 and GG.1.4.

If natural ventilation to outdoors is applied, all of the following shall be met:

- Natural ventilation to outdoors is not allowed below ground level.
- Natural ventilation from an occupied space shall not be made to outdoors.

NOTE 2 A user can block the natural ventilation to the outside if it is cold outside.

- The openings for natural ventilation shall comply with GG.1.4.
- The **maximum refrigerant charge** of a system, $m_{\max}$, and minimum opening area, $A_{\text{nv,min}}$, for natural ventilation to outdoors shall be calculated using the following formulae:

$$m_{\max} = \frac{\left(\frac{A_{\text{nv}}}{0,14}\right)^2}{\left(\frac{0,04}{\text{LFL}}\right)} \quad (\text{GG.20})$$

$$A_{\text{nv,min}} = 0,14 \times \sqrt{m_{\text{c}} \times \frac{0,04}{\text{LFL}}} \quad (\text{GG.21})$$

where

- m_{c} is the **refrigerant charge** of a system in kg;
- $m_{\max}$ is the **maximum refrigerant charge** for a system in kg;
- LFL is the **lower flammability limit** in kg/m³;
- A_{nv} is the opening area in m²;
- $A_{\text{nv,min}}$ is the minimum opening area in m²;
- 0,14 is a constant derived from the gravity acceleration, flow coefficient, etc;
- 0,04 is the conversion constant from hydrocarbon LFL to another LFL.

GG.8.3 Mechanical ventilation requirements for rooms with appliances using A2L refrigerants

GG.8.3.1 Operation of mechanical ventilation system

GG.8.3.1.1 General

Mechanical ventilation in compliance with GG.8.3.1.2 or GG.8.3.1.3 shall be provided.

GG.8.3.1.2 Continuous operation of mechanical ventilation system

The mechanical ventilation system shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below $Q_{\min}$, the following actions shall be taken:

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.8.3.1.3 Mechanical ventilation system activated by a leak detection system

If a **leak detection system** is activated, the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the mechanical ventilation system of the appliance to deliver indoor airflow at or above the minimum airflow $Q_{\min}$;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.8.3.2 Required airflow

The airflow shall be calculated using of the formula below. Losses caused by ducts or other components in the air stream shall be considered.

$$Q_{\min} = \frac{m_c - m_{\max}}{4 \times LFL} \times 2 \times 60 \quad (\text{GG.22})$$

where

- $Q_{\min}$ is the required airflow volume in m³/h;
- $m_{\max}$ is the **maximum refrigerant charge** for the system in the room in kg according to Formula (GG.8) or m_2 , whichever is lower, or Clause GG.9, where applicable;
- m_c is the actual **refrigerant charge** of a single **refrigerating system** expressed in kg;
- 4 is the assumed leak time (4 min);
- 2 is a safety factor of 2;
- 60 is the conversion minutes to hours;
- LFL is the **lower flammability limit** in kg/m³.

Mechanical ventilation shall be made to the outdoor or an indoor space where the room area is larger than the minimum area of the room which the mechanical ventilation exhausts into, $EA_{\min}$, calculated using the following formula:

$$EA_{\min} = (m_c - m_{\max}) / (CF \times LFL \times H) \quad (\text{GG.23})$$

where

- $EA_{\min}$ is the minimum area of the room which the mechanical ventilation exhausts into in m²;
- CF is the concentration factor with a value of 0,25;
- m_c is the **refrigerant charge** in kg;
- $m_{\max}$ is the allowable **maximum refrigerant charge** for the system in the room in kg;
- H is the height of the room = 2,2 m;
- LFL is the **lower flammability limit** in kg/m³.

GG.8.3.3 Requirement for opening

For mechanical ventilation as specified in GG.8.3, the lower edge of openings extracting air from the room shall not be more than 100 mm above the floor.

The openings extracting air from the room shall be positioned relative to the openings supplying air to the room such that the supplied makeup air mixes with the leaked refrigerant.

The openings exhausting air from the room shall be positioned relative to the intake openings supplying air to the room to prevent re-circulation back to the room.

GG.9 Charge limits for appliances using A2L refrigerants connected via an air duct system to one or more rooms**GG.9.1 General**

Clause GG.9 is applicable for appliances with a **refrigerant charge** of $m_1 < m_c \leq m_3$. The **maximum refrigerant charge** can be increased or the minimum room area can be reduced if the following requirements are met:

- The appliances shall be connected via an air duct system to one or more rooms, the supply and return air shall be directly ducted to the space. Open areas such as false ceilings shall not be used as a return air duct;
- Operation of **circulation airflow** shall comply with either GG.9.2 or GG.9.3.
- $m_{\max}$ shall be determined based on the total area of the conditioned space (TA) connected by ducts taking into consideration that the **circulation airflow** distributed to all the rooms by the appliance integral indoor fan will mix and dilute the leaking refrigerant before entering any room. In the case when no **refrigerant detection system** is provided, then spaces where the airflow can be limited by zoning dampers shall not be included in the determination of TA .

The minimum airflow shall be determined as:

$$Q_{\min} = 60 \times m_c / LFL \quad (\text{GG.24})$$

where

$Q_{\min}$ is the minimum **circulation airflow** circulated to the total conditioned space in m^3/h ;

m_c is the actual **refrigerant charge** for a single **refrigerating system** expressed in kg;

LFL is the **lower flammability limit** in kg/m^3 .

Compliance is checked by testing.

The **maximum refrigerant charge** based on the room area for the total conditioned space shall be in accordance with the following:

$$m_{\max} = CF \times LFL \times H \times TA \quad (\text{GG.25})$$

or

the required minimum total conditioned room area $TA_{\min}$ of the installed appliance with **refrigerant charge** m_c (kg) shall be in accordance with following:

$$TA_{\min} = m_c / (CF \times LFL \times H) \quad (\text{GG.26})$$

where

- CF is the concentration factor with a value of 0,50;
- $m_{\max}$ is the allowable **maximum refrigerant charge** in the system in kg;
- m_c is the **refrigerant charge** in appliance in kg;
- $TA_{\min}$ is the required minimum area of the total conditioned space in m^2 ;
- H is the height of the room = 2,2 m;
- TA is the area of the total conditioned space in m^2 ;
- LFL is the **lower flammability limit** in kg/m^3 .

If TA is smaller than $TA_{\min}$, additional ventilation according to GG.8.3 shall be employed.

GG.9.2 Continuous circulation airflow

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below $Q_{\min}$, the following actions shall be taken:

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.9.3 Circulation airflow activated by a leak detection system

If a **leak detection system** is activated, the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the fan(s) of the appliance to deliver indoor airflow at or above the minimum airflow $Q_{\min}$;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space;
- fully open all zoning dampers of the appliance and energize control signals to open any external zoning dampers if applicable;
- activate additional mechanical ventilation, if required by GG.8.3.

Compliance is checked by inspection.

Building fire and smoke systems may override this function.

GG.10 Allowable charge for enhanced tightness refrigerating systems using A2L refrigerant

GG.10.1 General

Clause GG.10 is applicable to **enhanced tightness refrigerating systems** in compliance with 22.125 using **A2L refrigerants** with **refrigerant charge** of $m_1 < m_c \leq m_3$.

For individual indoor units, when tested in accordance with ISO 5151, ISO 13253, or ISO 15042

- the cooling capacity shall not exceed 35 kW at T1 conditions;
- for heating only appliances, the heating capacity shall not exceed 35 kW at H1 conditions.

The applicable measures to be taken shall be ventilation (natural or mechanical), **safety shut-off valves** and safety alarm, in conjunction with **leak detection systems** as specified in GG.10.2. A safety alarm alone shall not be considered as an appropriate measure where occupants are restricted in their movement (see Clause GG.13).

NOTE Clause GG.10 assumes a leak rate of not more than 10 kg per hour.

GG.10.2 Required measures for allowable refrigerant charge

GG.10.2.1 General

For appliances where the **refrigerant charge** does not exceed **maximum refrigerant charge** in GG.10.3.1, no additional measures are required.

GG.10.2.2 Spaces except lowest underground floor of the building

For appliances with release height, h_0 , as determined in Clause GG.2, equal to or greater than 1,8 m or with integral **circulation airflow** (see GG.10.4), where the **refrigerant charge** does not exceed **maximum refrigerant charge** in GG.10.3.2, no additional measures are required.

For appliances without integral **circulation airflow** and having release height, h_0 , less than 1,8 m, where the **refrigerant charge** exceeds the **maximum refrigerant charge** in GG.10.3.1, but is less than or equal to the **maximum refrigerant charge** in GG.10.3.2, one additional measure shall be taken in accordance with Clause GG.11, Clause GG.12 or Clause GG.13.

Where the **refrigerant charge** exceeds the **maximum refrigerant charge** in GG.10.3.2, a safety alarm shall be employed in accordance with Clause GG.13, and one additional measure shall be taken in accordance with Clause GG.11 or Clause GG.12.

GG.10.2.3 Lowest underground floor of the building

For appliances without integral **circulation airflow** and having release height, h_0 , as determined in Clause GG.2, less than 1,8 m, where the **refrigerant charge** exceeds the **maximum refrigerant charge** in GG.10.3.1, but is less than or equal to the **maximum refrigerant charge** in GG.10.3.2, a safety alarm shall be employed in accordance with Clause GG.13, and one additional measure shall be taken in accordance with Clause GG.11 or Clause GG.12.

For appliances with release height, h_0 , equal to or greater than 1,8 m or with integral **circulation airflow** (see GG.10.4), where the **refrigerant charge** exceeds the **maximum refrigerant charge** in GG.10.3.1, but is less than or equal to the **maximum refrigerant charge** in GG.10.3.2, one additional measure shall be taken in accordance with Clause GG.11, Clause GG.12 or Clause GG.13.

The **refrigerant charge** shall not exceed the **maximum refrigerant charge** in GG.10.3.2.

GG.10.3 Maximum refrigerant charge

GG.10.3.1 Maximum refrigerant charge limit A

The **maximum refrigerant charge** $m_{\max}$ in a room and the minimum room area $A_{\min}$ of the installed appliance with **refrigerant charge** m_c shall be in accordance with the following:

$$m_{\max} = CF \times LFL \times H_r \times A \quad (\text{GG.27})$$

$$A_{\min} = m_c / (CF \times LFL \times H_r) \quad (\text{GG.28})$$

where

CF is the concentration factor with a value of 0,50;

$m_{\max}$ is the **maximum refrigerant charge** in kg;

m_c is the total **refrigerant charge** in the **refrigerating system** in kg;

LFL is the **lower flammability limit** in kg/m³;

H_r is the effective height of the indoor unit in m;

A is the room floor area in m²;

$A_{\min}$ is the required minimum room area in m².

The effective height, H_r , of the unit is determined as follows:

- Where the release height, h_0 , as determined in Clause GG.2 is equal to or greater than 1,8 m or the appliance is with integral **circulation airflow**, the effective height, H_r , is the room height in m but not more than 2,2 m unless h_0 is higher than 2,2 m.
- In all other cases, the effective height, H_r , is the release height, h_0 , as determined in Clause GG.2.

For room areas exceeding 250 m², $m_{\max}$ shall be calculated with a room area (A) of 250 m².

GG.10.3.2 Maximum refrigerant charge limit B

The **maximum refrigerant charge**, $m_{\max}$, in a room and the minimum room area, $A_{\min}$, of the installed appliance with **refrigerant charge**, m_c , shall be in accordance with the following:

$$m_{\max} = CF \times LFL \times H_r \times A \quad (\text{GG.29})$$

$$A_{\min} = m_c / (CF \times LFL \times H_r) \quad (\text{GG.30})$$

where

CF is the concentration factor with a value of 0,75;

$m_{\max}$ is the **maximum refrigerant charge** in kg;

m_c is the total **refrigerant charge** in the **refrigerating system** in kg;

LFL is the **lower flammability limit** in kg/m³;

H_r is the effective height of the indoor unit in m;

A is the room floor area in m²;

$A_{\min}$ is the required minimum room area in m².

The effective height, H_r , of the unit is determined as follows:

- Where the release height, h_0 , as determined in Clause GG.2, is equal to or greater than 1,8 m or the appliance is with integral **circulation airflow**, the effective height, H_r , is the room height in m but not more than 2,2 m unless h_0 is higher than 2,2 m.
- In all other cases, the effective height, H_r , is the release height, h_0 , as determined in Clause GG.2.

For room areas exceeding 250 m², $m_{\max}$ shall be calculated with a room area (A) of 250 m².

GG.10.4 Requirement for units with integral circulation airflow

GG.10.4.1 General

The minimum air velocity and minimum airflow shall be as follows:

- Minimum airflow = 240 m³/h.
- There is no minimum **circulation airflow** velocity requirement for downwards airflow.
- Minimum air velocity for upwards airflow:

$$v_{\min} = (-4,0 \times 10^{-5} \times M^2 + 0,0108 \times M + 1,42) / \sin \varphi \quad (\text{GG.31})$$

where

$v_{\min}$ is the minimum air velocity in m/s;

M is the molar mass in kg/kmol;

φ is the airflow angle above horizontal in degrees; an angle below 15° is considered to be 15°.

- The unit air velocity (v) shall be calculated as airflow divided by the nominal face area of the outlet. The grille area shall not be deducted.

NOTE The formula is based on appliances with a refrigerant release on floor level, which represents the most stringent situation.

As an alternative, for airflow angles between 15° and 90°, the minimum air velocity ($v_{\min}$) can be determined by linear interpolation of the values included in Table GG.5.

Compliance is checked by testing.

Operation of **circulation airflow** shall comply with either GG.10.4.2 or GG.10.4.3.

GG.10.4.2 Continuous circulation airflow

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below $Q_{\min}$, the following actions shall be taken:

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.10.4.3 Circulation airflow activated by a leak detection system

If a **leak detection system** is activated, the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the fan(s) of the appliance to deliver indoor airflow at or above the minimum airflow $Q_{\min}$;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.11 Ventilation for enhanced tightness refrigerating systems using A2L refrigerants

GG.11.1 General

Ventilation shall be made to a place where sufficient air is available to dilute the leaked refrigerant, such as outdoors or a large space.

Where ventilation is to an indoor space, the total area of that space and the space in which the appliance is installed shall have a total room area not less than $A_{\min}$ according to the Formula (GG.32). If the opening area in GG.11.2 is not large enough, the measure of GG.11.3 shall be taken with ventilation to the outdoors.

$$A_{\min} = m_c / (CF \times LFL \times H_r) \quad (\text{GG.32})$$

where

- CF is the concentration factor with a value of 0,50;
- m_c is the total **refrigerant charge** in the **refrigerating system** in kg;
- LFL is the **lower flammability limit** in kg/m³;
- H_r is the effective height of the indoor unit in m;
- $A_{\min}$ is the required minimum room area in m².

The effective height, H_r , of the unit is determined as follows:

- where the release height, h_0 , as determined in Clause GG.2, is equal to or greater than 1,8 m or the appliance is with integral **circulation airflow**, the effective height, H_r , is the room height in m but not more than 2,2 m unless h_0 is higher than 2,2 m;
- in all other cases, the effective height, H_r , is the release height, h_0 , as determined in Clause GG.2.

GG.11.2 Natural ventilation

If natural ventilation is applied, the following shall be met:

- Openings for natural ventilation shall comply with GG.1.4.
- Natural ventilation to outdoors is not allowed below ground level.
- Natural ventilation from an occupied space shall not be made to outdoors.

NOTE User can block the natural ventilation to the outside if it is cold outside.

The minimum opening area for natural ventilation ($A_{nv,min}$) to an indoor space shall be:

$$A_{nv,min} = \frac{1}{720 \times LFL} \times \sqrt{\frac{M}{LFL \times (M - 29)}} \quad (GG.33)$$

where

- $A_{nv,min}$ is the minimum required natural ventilation opening area in m²;
- M is the molar mass in kg/kmol;
- LFL is the **lower flammability limit** expressed in kg/m³;
- 720 is the coefficient resulting from calculating all the constants used to establish the formula;
- 29 is the average molar mass of air in kg/kmol.

The minimum opening area for natural ventilation ($A_{nv,min}$) to an outdoor space shall be:

$$A_{nv,min} = 0,14 \times \sqrt{m_c \times \frac{0,04}{LFL}} \quad (GG.34)$$

where

- m_c is the **refrigerant charge** of a system in kg;
- LFL is the **lower flammability limit** in kg/m³;
- $A_{nv,min}$ is the minimum required natural ventilation opening area in m²;
- 0,14 is a constant derived from the gravity acceleration, flow coefficient, etc.;
- 0,04 is the conversion constant from hydrocarbon to another LFL.

GG.11.3 Mechanical ventilation

GG.11.3.1 Operation of mechanical ventilation

Mechanical ventilation shall be operated continuously or shall be switched on by a **leak detection system**.

Operation shall be according to GG.8.3.1.

GG.11.3.2 Required airflow

For $(Q_{min} \times 0,25 \times LFL)/10 < 1$, the airflow of the mechanical ventilation shall be at least the quantity that satisfies the following formula:

$$m_c = \frac{10 \times V}{Q_{min}} \ln \left(1 - \frac{Q_{min} \times 0,25 \times LFL}{10} \right) \quad (GG.35)$$

For $(Q_{\min} \times 0,25 \times LFL)/10 \geq 1$, the airflow shall be determined according to the following formula:

$$Q_{\min} = \frac{10}{0,25 \times LFL} \quad (\text{GG.36})$$

where

m_c is the **refrigerant charge**, expressed in kg;

V is the room volume in m^3 ;

10 is the expected maximum leak rate in kg/h;

$Q_{\min}$ is the ventilation airflow in m^3/h ;

LFL is the **lower flammability limit** in kg/m^3 .

Losses caused by ducts or other components in the air stream shall be considered.

GG.11.3.3 Mechanical ventilation openings

The upper edge of the air extraction opening from the room shall be located at a height equal to or below the refrigerant release point.

The mechanical ventilation air extracted from the space shall be positioned relative to the mechanical ventilation air intake openings such that the makeup air will mix with the leaked refrigerant.

Where **circulation airflow** according to GG.10.4 is not provided, the openings shall comply with GG.8.3.3.

GG.12 Safety shut-off valves for enhanced tightness refrigerating systems using A2L refrigerants

Safety shut-off valves shall be positioned to enable access for maintenance by an authorized person.

For appliances which are not on the lowest underground floor, where the release height, h_0 , as determined in Clause GG.2 is equal to or greater than 1,8 m or the appliance is with integral **circulation airflow**, the **releasable charge** as determined by Annex QQ shall be limited to:

$$m_{rl} < CF \times LFL \times H_r \times A \quad (\text{GG.37})$$

where

CF is the concentration factor with a value of 0,75;

m_{rl} is the **releasable charge** in kg;

LFL is the **lower flammability limit** in kg/m^3 ;

H_r is the effective height of the indoor unit as determined in GG.10.3 in m;

A is the room floor area in m^2 .

For all other appliances, the **releasable charge** as determined by Annex QQ shall be limited to:

$$m_{rl} < CF \times LFL \times H_r \times A \quad (GG.38)$$

where

CF is the concentration factor with a value of 0,50;

m_{rl} is the **releasable charge** in kg;

LFL is the **lower flammability limit** in kg/m³;

H_r is the effective height of the indoor unit as determined in GG.10.3 in m;

A is the room floor area in m².

GG.13 Safety alarms for enhanced tightness refrigerating systems using A2L refrigerants

GG.13.1 General

If a safety alarm is employed to warn of a leak in the occupied space, the safety alarm shall warn of a refrigerant leak in accordance with GG.13.2. The safety alarm shall be turned on by the signal from the **leak detection system**. The safety alarm shall also alert an authorized person to take appropriate action.

GG.13.2 Safety alarm system warning

GG.13.2.1 General

The safety alarm system shall warn both audibly and visibly, such as both a loud (15 dBA above the background level) buzzer and a flashing light.

GG.13.2.2 Safety alarm for general occupancy

At least one safety alarm inside the occupied space shall be installed. For the occupancy listed below, the safety alarm system shall also warn at a supervised location, such as the night porter's location, as well as the occupied space:

- rooms, parts of buildings, building where sleeping facilities are provided;
- rooms, parts of buildings, building where people are restricted in their movement;
- rooms, parts of buildings, building where an uncontrolled number of people are present; or
- rooms, parts of buildings, building to which any person has access without being personally acquainted with the necessary safety precautions.

Table GG.5 – Minimum air velocity

Minimum air velocity							
$v_{\min}$ (m/s)							
h_a (m)	M	Airflow angle above horizontal					
		φ (degrees)					
		15	30	45	60	75	90
< 0,3	50	7,08	3,67	2,59	2,12	1,90	1,83
	60	7,40	3,83	2,71	2,21	1,98	1,92
	70	7,62	3,94	2,79	2,28	2,04	1,97
	80	7,78	4,03	2,85	2,32	2,08	2,01
	90	7,90	4,09	2,89	2,36	2,12	2,04
	100	8,00	4,14	2,93	2,39	2,14	2,07
	110	8,07	4,18	2,96	2,41	2,16	2,09
	120	8,14	4,21	2,98	2,43	2,18	2,11
< 0,60	50	6,47	3,35	2,37	1,93	1,73	1,67
	60	6,76	3,50	2,47	2,02	1,81	1,75
	70	6,96	3,60	2,55	2,08	1,86	1,80
	80	7,10	3,68	2,60	2,12	1,90	1,84
	90	7,21	3,73	2,64	2,16	1,93	1,87
	100	7,30	3,78	2,67	2,18	1,96	1,89
	110	7,37	3,82	2,70	2,20	1,97	1,91
	120	7,43	3,85	2,72	2,22	1,99	1,92
< 0,90	50	5,78	2,99	2,12	1,73	1,55	1,50
	60	6,04	3,13	2,21	1,81	1,62	1,56
	70	6,22	3,22	2,28	1,86	1,67	1,61
	80	6,35	3,29	2,32	1,90	1,70	1,64
	90	6,45	3,34	2,36	1,93	1,73	1,67
	100	6,53	3,38	2,39	1,95	1,75	1,69
	110	6,59	3,41	2,41	1,97	1,77	1,71
	120	6,64	3,44	2,43	1,99	1,78	1,72
< 1,20	50	5,01	2,59	1,83	1,50	1,34	1,30
	60	5,23	2,71	1,92	1,56	1,40	1,35
	70	5,39	2,79	1,97	1,61	1,44	1,39
	80	5,50	2,85	2,01	1,64	1,47	1,42
	90	5,59	2,89	2,04	1,67	1,50	1,45
	100	5,65	2,93	2,07	1,69	1,52	1,46
	110	5,71	2,96	2,09	1,71	1,53	1,48
	120	5,75	2,98	2,11	1,72	1,54	1,49

Minimum air velocity							
$v_{\min}$ (m/s)							
h_a (m)	M	Airflow angle above horizontal φ (degrees)					
		15	30	45	60	75	90
< 1,50	50	4,09	2,12	1,50	1,22	1,10	1,06
	60	4,27	2,21	1,56	1,28	1,15	1,11
	70	4,40	2,28	1,61	1,31	1,18	1,14
	80	4,49	2,32	1,64	1,34	1,20	1,16
	90	4,56	2,36	1,67	1,36	1,22	1,18
	100	4,62	2,39	1,69	1,38	1,24	1,19
	110	4,66	2,41	1,71	1,39	1,25	1,21
	120	4,70	2,43	1,72	1,40	1,26	1,22
< 1,80	50	2,89	1,50	1,06	0,86	0,77	0,75
	60	3,02	1,56	1,11	0,90	0,81	0,78
	70	3,11	1,61	1,14	0,93	0,83	0,81
	80	3,18	1,64	1,16	0,95	0,85	0,82
	90	3,23	1,67	1,18	0,96	0,86	0,83
	100	3,26	1,69	1,19	0,98	0,87	0,84
	110	3,30	1,71	1,21	0,99	0,88	0,85
	120	3,32	1,72	1,22	0,99	0,89	0,86

h_a is the air delivery height in the upper side in m.

GG.14 Allowable charge for enhanced tightness refrigerating systems using A2 or A3 refrigerant

GG.14.1 General

Clause GG.14 is applicable to **enhanced tightness refrigerating systems** in compliance with 22.125 using A2 or A3 refrigerants with **refrigerant charge** of $m_1 < m_c \leq m_2$.

GG.14.2 Requirement for enhanced tightness units without integral circulation airflow

For **enhanced tightness refrigerating systems**, the **maximum refrigerant charge** in a room shall be in accordance with the following:

$$m_{\max} = CF \times LFL \times A \times h_0 \quad (\text{GG.39})$$

or the required minimum room area $A_{\min}$ of installed appliance with **refrigerant charge** m_c shall be in accordance with the following:

$$A_{\min} = m_c / (CF \times LFL \times h_0) \quad (\text{GG.40})$$

where

- CF is a concentration factor with a value of 0,35;
 $m_{\max}$ is the allowable **maximum refrigerant charge** in the system in kg;
 m_c is the actual **refrigerant charge** in the system in kg;
 $A_{\min}$ is the required minimum room area in m²;
 h_0 is the release height, the vertical distance in metres from the floor to the point of release when the appliance is installed (see Figure GG.3) according to GG.2.1 but not less than 0,6 m and not to exceed 2,2 m;
 A is the room area in m²;
 LFL is the **lower flammability limit**, in kg/m³.

GG.14.3 Requirement for enhanced tightness units with integral circulation airflow

GG.14.3.1 General

When the fan integrated into an appliance is continuously operated or operation is initiated by a **leak detection system** with sufficient airflow rate, the **maximum refrigerant charge** can be increased or the minimum room area can be reduced according to the following.

For **enhanced tightness refrigerating systems**, the **maximum refrigerant charge** in a room shall be in accordance with the following:

$$m_{\max} = CF \times LFL \times A \times 2,2 \quad (\text{GG.41})$$

or the required minimum room area $A_{\min}$ of installed appliance with **refrigerant charge** m_c shall be in accordance with the following:

$$A_{\min} = m_c / (CF \times LFL \times 2,2) \quad (\text{GG.42})$$

where

- $m_{\max}$ is the allowable **maximum refrigerant charge** in the system in kg;
 CF is a concentration factor specified by the manufacturer and not exceeding 0,5. CF shall be the same value as used in in Formula (GG.43) for calculating $Q_{\min}$;
 m_c is the actual **refrigerant charge** in the system in kg;
 $A_{\min}$ is the required minimum room area in m²;
2,2 is the room height in m;
 A is the room area in m²;
 LFL is the **lower flammability limit**, in kg/m³.

NOTE 1 A lower value of CF can be specified to give a lower airflow requirement, and it results in a *higher* $A_{\min}$ and *lower* $m_{\max}$.

The minimum **circulation airflow** shall be determined as:

$$Q_{\min} = 3\,600 \frac{5Y \sqrt{A_o} \dot{m}_{\text{leak}}^{3/4}}{h_o^{1/4} [\text{LFL} \times (1 - \text{CF})]^{5/8}} \quad (\text{GG.43})$$

where

$Q_{\min}$ is the required airflow volume in m^3/h ;

3 600 is a constant to convert m^3/s to m^3/h ;

A_o is the airflow discharge area of the appliance in m^2 . The value is the nominal face area of the outlet. The grille area shall not be deducted;

Y is a constant, if there are leak sources outside the unit $Y = 1,5$, otherwise $Y = 1$;

$\dot{m}_{\text{leak}}$ is the refrigerant leak rate as determined in Table GG.6 in kg/s ;

h_o is the release height, the vertical distance in metres from the floor to the point of release when the appliance is installed (see Figure GG.3) according to GG.2.1 but not less than 0,6 m and not to exceed 2,2 m;

LFL is the **lower flammability limit** in kg/m^3 ;

CF is a concentration factor not exceeding 0,5. The value shall be the value as used in Formula (GG.41) and Formula (GG.42) for calculating $m_{\max}$ and $A_{\min}$.

Table GG.6 – Refrigerant leak rate ($\dot{m}_{\text{leak}}$)

Refrigerant	Refrigerant leak rate kg/s
R152a	0,000 92
RE170	0,000 74
R290	0,001 12
R600	0,000 34
R600a	0,000 48
R1270	0,001 35

NOTE The values were calculated using Formulae (GG.44) and (GG.45) using properties from REFPROP 9.1¹². Properties of selected refrigerants are also available in ISO 17584.

For refrigerants not listed in Table GG.6, leak mass flow rate ($\dot{m}_{\text{leak}}$) is calculated from:

$$\dot{m}_{\text{leak}} = (167/432) 10^{-6} \dot{M}_s \quad (\text{GG.44})$$

where

$\dot{m}_{\text{leak}}$ is the assumed leak rate from the system in kg/s ;

167 is a reference leak mass flow rate in g/min ;

¹² REFPROP 9.1 is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of this product.

432 *is a coefficient;*

$\dot{M}_S$ *is the choked flow mass flux in kg/m²s.*

The choked flow mass flux, $\dot{M}_S$, is:

$$\dot{M}_S = 0,61 \times \sqrt{k \rho_0 p_0 \left(\frac{2}{k+1} \right)^{\frac{k+1}{k-1}}} \quad (\text{GG.45})$$

where

0,61 *is the discharge coefficient;*

k *is the ratio of specific heats of refrigerant vapour;*

ρ_0 *is the density of saturated refrigerant vapour at 45 °C in kg/m³ at the system pressure p_0 ;*

p_0 *is the pressure in the system at 45 °C in Pa.*

NOTE 2 REFPROP¹³ is an example of a commercial product providing values for k . Properties of selected refrigerants are also available in ISO 17584.

Compliance is checked by testing.

Operation of **circulation airflow** shall comply with either GG.14.3.2 or GG.14.3.3.

GG.14.3.2 Continuous circulation airflow

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below $\dot{Q}_{\min}$, the following actions shall be taken:

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.14.3.3 Circulation airflow activated by a leak detection system

If a **leak detection system** is activated, the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the fan(s) of the appliance to deliver indoor airflow at or above the minimum airflow $\dot{Q}_{\min}$;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

¹³ REFPROP is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of this product.

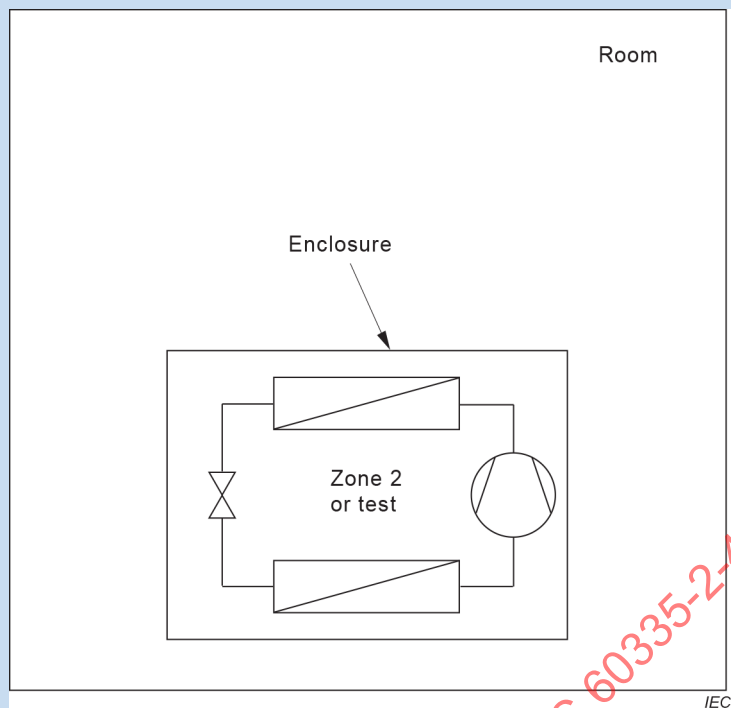


Figure GG.1 – Unventilated area

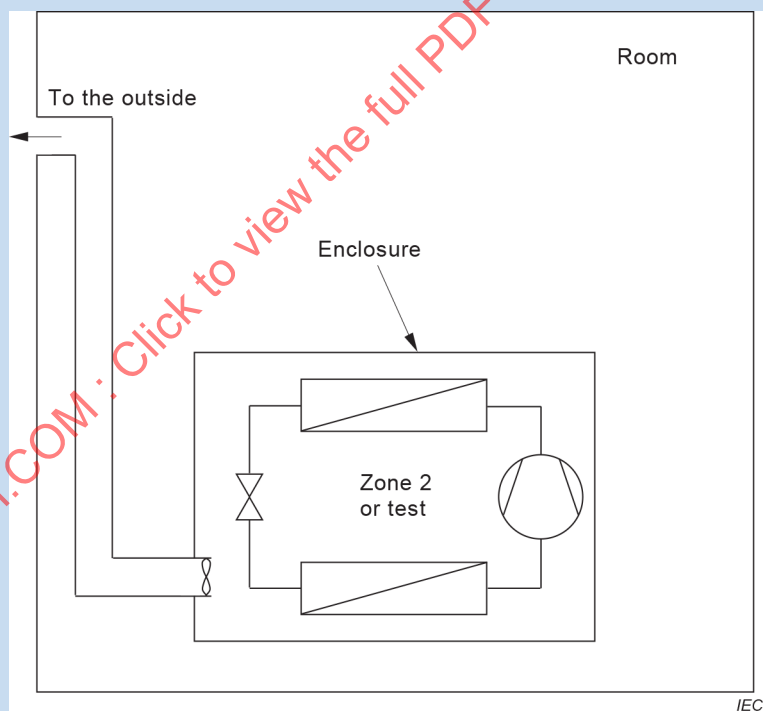


Figure GG.2 – Mechanical ventilation

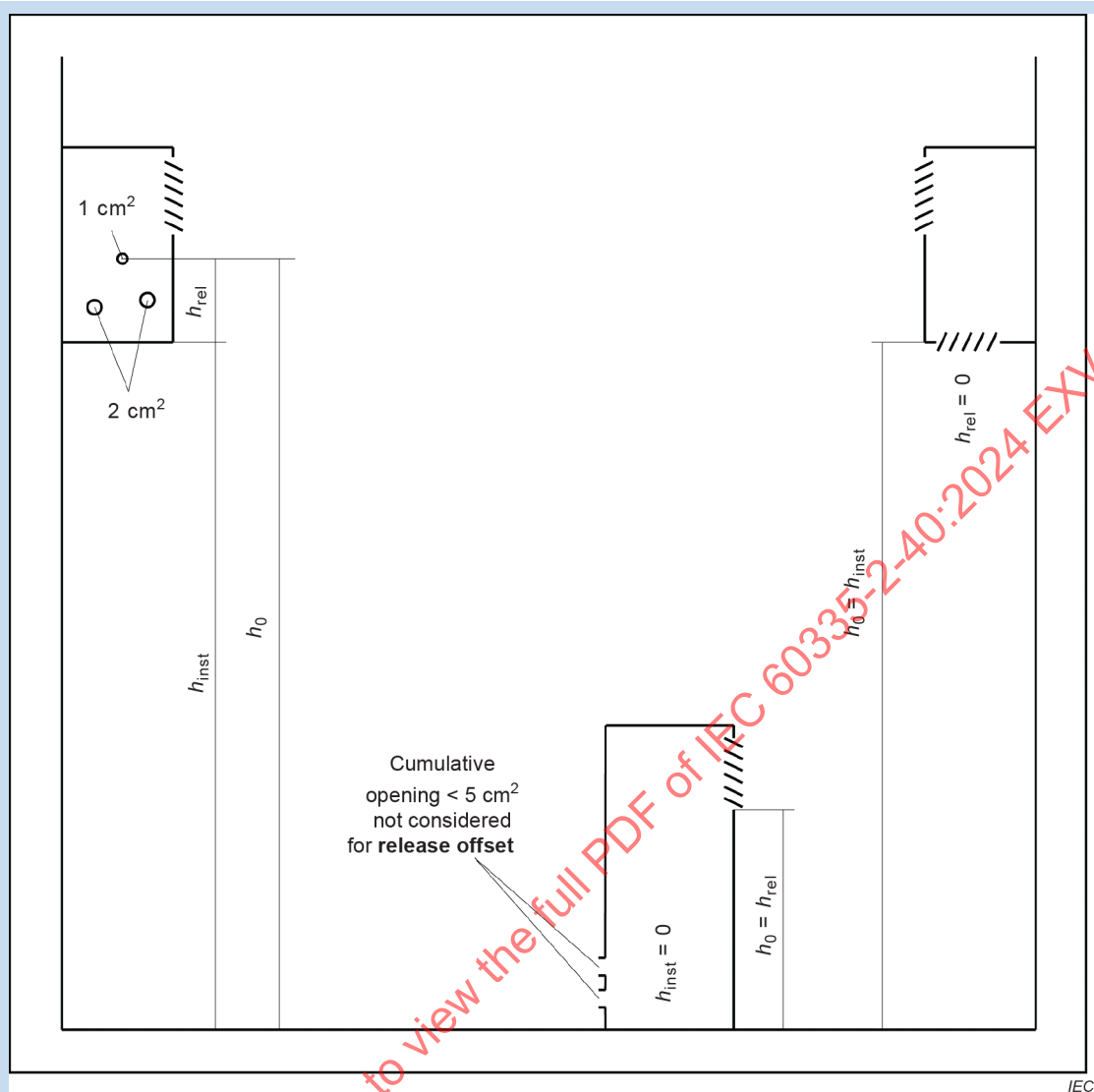
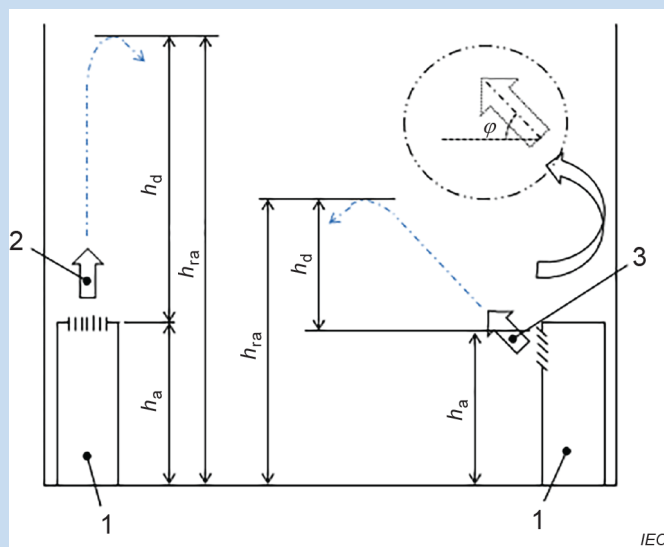


Figure GG.3 – Relevant heights h_{inst} , h_0 and h_{rel} for calculation of $A_{\min}$ and $m_{\max}$



Key

- 1 appliance
- 2 airflow direction: Upwards (vertical $\phi = 90^\circ$)
- 3 airflow direction: Upwards

Figure GG.4 – Airflow direction

Annex HH (informative)

Competence of service personnel

HH.1 General

Information on procedures additional to the usual information for refrigerating appliance installation, repair, maintenance and decommission procedures is required when an appliance with **flammable refrigerants** is affected.

The training in these procedures is carried out by training organizations or manufacturers that are competent to teach the relevant national competency standards that can be set in legislation.

The achieved competence should be documented by a certificate.

HH.2 Information and training

HH.2.1 The training should include the substance of the following:

HH.2.2 Information about the explosion potential of **flammable refrigerants** to show that flammables can be dangerous when handled without care.

HH.2.3 Information about potential ignition sources, especially those that are not obvious, such as lighters, light switches, vacuum cleaners, electric heaters.

HH.2.4 Information about the different safety concepts:

- Unventilated (see Clause GG.2): Safety of the appliance does not depend on ventilation of the housing. Switching off the appliance or opening of the housing has no significant effect on safety. Nevertheless, it is possible that leaking refrigerant can accumulate inside the enclosure and flammable atmosphere will be released when the enclosure is opened.
- Ventilated enclosure (see Clause GG.4): Safety of the appliance depends on ventilation of the housing. Switching off the appliance or opening of the enclosure has a significant effect on safety. Care should be taken to ensure sufficient ventilation before switching off.
- Ventilated room (see Clause GG.5): Safety of the appliance depends on the ventilation of the room. Switching off the appliance or opening of the housing has no significant effect on safety. The ventilation of the room shall not be switched off during repair procedures.

HH.2.5 Information about refrigerant detectors:

- principle of function, including influences on the operation;
- procedures for how to repair, check or replace a refrigerant detector or parts of it in a safe way;
- procedures for how to disable a refrigerant detector in case of repair work on the refrigerant carrying parts.

HH.2.6 Information about the correct working procedures:

a) Commissioning

- Ensure that the floor area is sufficient for the **refrigerant charge** or that the ventilation duct is assembled in a correct manner.
- Connect the pipes and carry out a leak test before charging with refrigerant.
- Check safety equipment before putting into service.

b) Maintenance

- Portable equipment shall be repaired outside or in a workshop specially equipped for servicing units with **flammable refrigerants**.
- Ensure sufficient ventilation at the repair place.
- Be aware that malfunction of the equipment can be caused by refrigerant loss and that a refrigerant leak is possible.
- Discharge capacitors in a way that will not cause any spark. The standard procedure to short circuit the capacitor terminals usually creates sparks.
- Reassemble sealed enclosures accurately. If seals are worn, replace them.
- Check safety equipment before putting into service.

c) Repair

- Portable equipment shall be repaired outside or in a workshop specially equipped for servicing units with **flammable refrigerants**.
- Ensure sufficient ventilation at the repair place.
- Be aware that malfunction of the equipment can be caused by refrigerant loss and a refrigerant leak is possible.
- Discharge capacitors in a way that will not cause any spark.
- When brazing is required, the following procedures shall be carried out in the right order:
 - Remove the refrigerant and evacuate the system according to Clause DD.8.
 - Carry out a leak test before charging with refrigerant.
- Reassemble sealed enclosures accurately. If seals are worn, replace them.
- Check safety equipment before putting into service.

d) Decommissioning

- If the safety is affected when the equipment is taken out of service, the **refrigerant charge** shall be removed before decommissioning.
- Ensure sufficient ventilation at the equipment location.
- Be aware that malfunction of the equipment can be caused by refrigerant loss and a refrigerant leak is possible.
- Discharge capacitors in a way that will not cause any spark.
- Remove the refrigerant. If the recovery is not required by national regulations, drain the refrigerant to the outside. Take care that the drained refrigerant will not cause any danger. In doubt, one person should guard the outlet. Take special care that the drained refrigerant will not float back into the building.
- When **flammable refrigerants** except **A2L refrigerants** are used:
 - evacuate the refrigerant circuit,
 - purge the refrigerant circuit with inert gas for 5 min,
 - evacuate again,
 - fill with inert gas up to atmospheric pressure,
 - put a label on the equipment that the refrigerant is removed.

e) Disposal

- National regulations can apply.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex II

(Void)

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex JJ (normative)

Allowable openings of relays and similar components to prevent ignition of A2L refrigerants

JJ.1 General

Annex JJ is applicable to electrical components or devices of appliances using **A2L refrigerants**.

Annex JJ defines the maximum size of openings in relays and similar components that prevent flame propagation to the outside. A relay and similar components that comply with the requirements of this annex are not considered as a potential ignition source for **A2L refrigerants**.

JJ.2 Definition of the opening

The effective diameter is the equivalent diameter of a circular opening that has the same quenching effect to an opening of any shape. For conical holes, the smallest diameter shall be considered. The effective diameter of the openings of relays and similar components is defined as follows:

$$d_{\text{eff}} = 4 \times \frac{A}{S} \quad (\text{JJ.1})$$

where

- d_{eff} is the effective diameter in mm;
- A is the cross-sectional area of opening in mm²;
- S is the length of perimeter of opening in mm.

JJ.3 Determination of maximum allowable opening

Relays and similar components shall not be considered as a potential ignition source if the effective diameter, d_{eff} , of all holes is less than or equal to 7 mm and complies with the following formula:

$$d_{\text{eff}} < 22,3 \times S_u^{-1,09} \quad (\text{JJ.2})$$

where

- d_{eff} is the effective diameter in mm;
- S_u is the burning velocity in cm/s.

Alternatively, a type test can be used to determine if relays and similar components are not a potential ignition source. This type test shall show that there is no propagation of a flame from any contact inside of the relay to the outside, for the concentration of the refrigerant as used for determining the maximum burning velocity. Where the type test is used, the effective diameter limit is 12 mm.

Compliance is checked by inspection or by the following test: At the position of the contact, the refrigerant shall be ignited. It shall be observed if any propagation to the outside of the relay or similar component enclosure occurs. The test shall be repeated five times on the same sample and no propagation shall occur outside the relay or similar component. The test condition should be at the highest burning velocity as specified in 22.116.

NOTE A type test conducted with a refrigerant with a higher burning velocity can be used as evidence to show compliance for a refrigerant with a lower burning velocity.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex KK (normative)

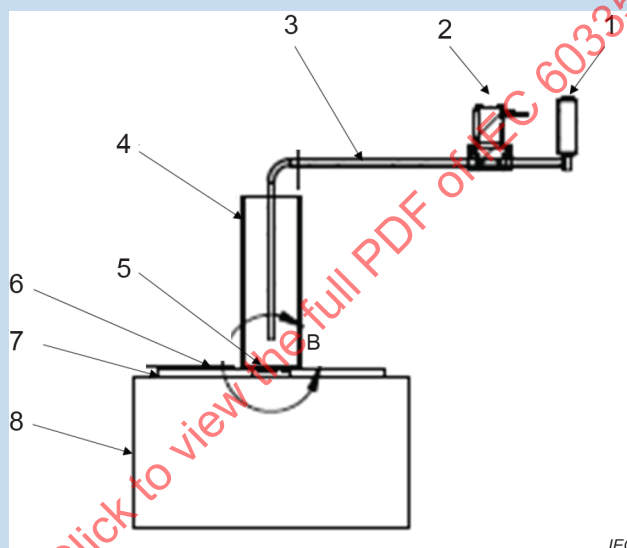
Test method for hot surface ignition temperature for A2L

KK.1 General

The **hot surface ignition temperature** of **A2L refrigerants** shall be determined according to Annex KK. The refrigerants shall be sprayed onto a horizontal flat plate surface which is set at the test temperature.

The test system consists of a hot plate, a spray tube and a chimney. Figure KK.1, Figure KK.2 and Figure KK.3 display the set-up of the test apparatus.

NOTE This method is a modification of the ASTM D6668. The ASTM test is designed for automotive fluids as a pass fail test at 815 °C. Annex KK is concerned with liquefied refrigerants and defining the maximum no ignition temperature.

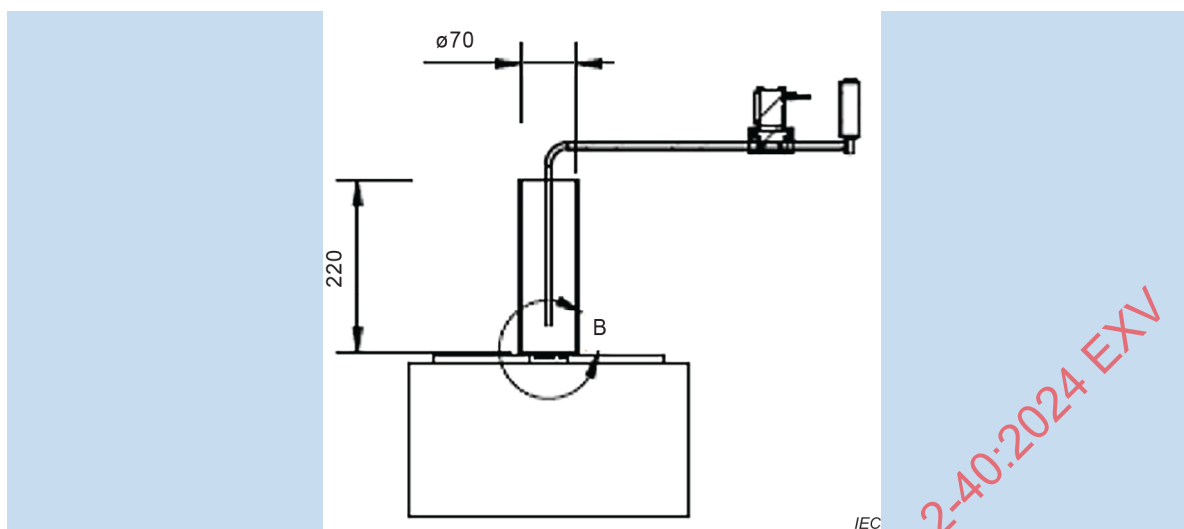


Key

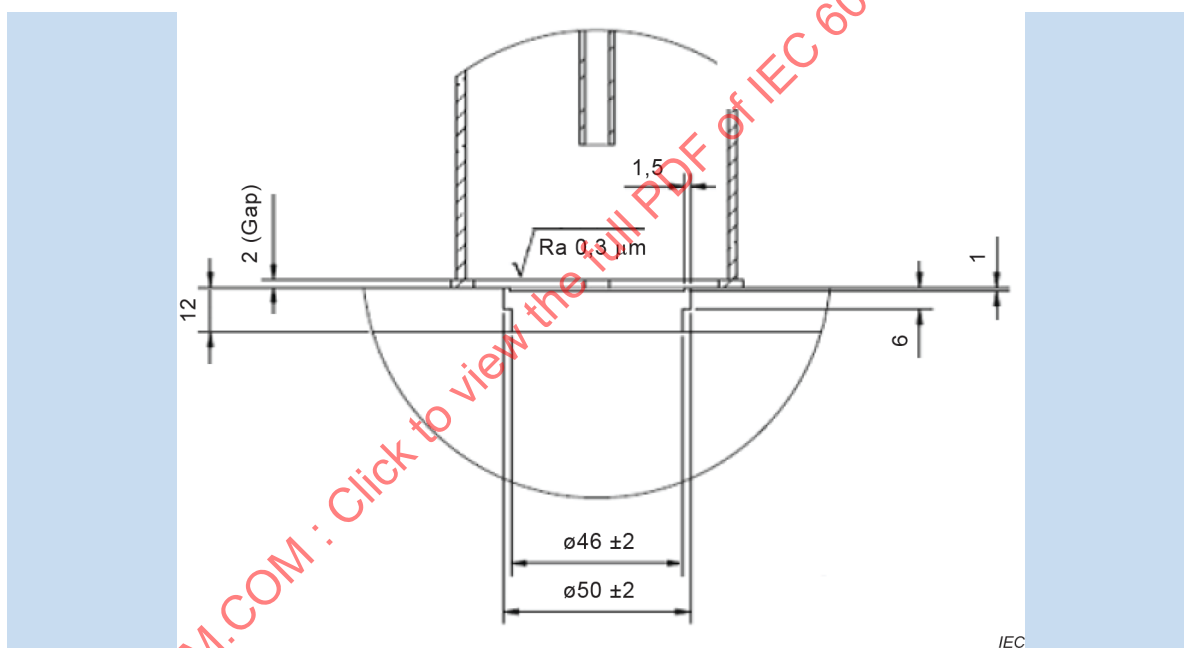
- 1 refrigerant cylinder with valve
- 2 valve
- 3 spray tube
- 4 glass cylinder
- 5 metal disc
- 6 thermocouple
- 7 insulation
- 8 hot plate

Figure KK.1 – Front view of test apparatus labels

Dimensions in millimetres



a) Front view with dimensions



b) Detail of section B

Figure KK.2 – Test apparatus with dimensions

Dimensions in millimetres

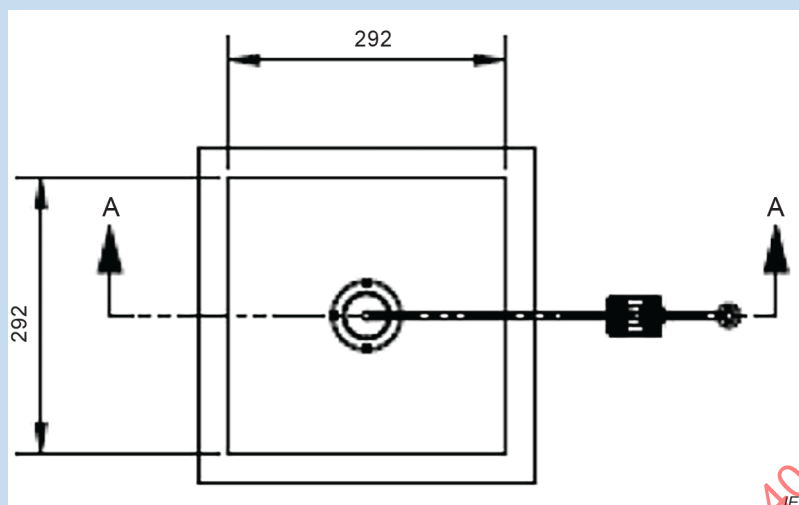


Figure KK.3 – Top view of test apparatus

KK.2 Test equipment requirements

The hot plate shall have the following characteristics. The hot plate shall consist of a flat stainless steel plate with the dimensions:

Diameter: 50 mm $\pm$ 2,0 mm

Thickness: 6 $^{+2}_{0}$ mm

Surface texture: ISO 1302

The hot plate shall be positioned horizontally. The heaters shall provide uniform heating of the plate. All surfaces other than the test surface should be thermally insulated using ceramic fibre board capable to withstand 815 °C. This insulation shall be such that vapours cannot be ignited by other than the hot plate top surface.

Spray system shall consist of a liquid supply, two valves (trap liquid volume of 1,0 cm³ $\pm$ 0,2 cm³), tubing for directing the spray. The spray tube from valve to the end shall have the following dimensions:

Length: 250 mm $\pm$ 5,0 mm

Outer diameter: $\leq$ 4 mm

Inner diameter: 1,6 mm $\pm$ 0,1 mm

Use a type K thermocouple with the individual wires spot welded on opposite sides of the centre of the upper surface of the hot plate.

A borosilicate or quartz glass chimney shall be 230 mm $\pm$ 10 mm long and have a 70 mm $\pm$ 10 mm inner diameter. The chimney shall be supported so that it is vertically mounted and has a gap of 2,5 mm $\pm$ 0,2 mm between its bottom edge and the top of the insulation.

KK.3 Procedure

The ambient conditions of the test shall be set at 23 °C $\pm$ 3 °C and 50 % RH $\pm$ 5 % RH. The chimney and hot plate establish a constant air velocity during the test. This airflow dilutes the vapours so that an optimum (near stoichiometric) concentration for ignition develops over the hot surface.

The test shall be performed in a laboratory fume hood. The test apparatus including the chimney top shall be located in the laminar flow region of the laboratory fume hood so the chimney flow is not disturbed.

The end of the spray refrigerant line shall be placed $40 \text{ mm} \pm 10 \text{ mm}$ above the hot plate and shall point to the centre of the hot plate. The tube shall be perpendicular to the horizontal plate.

Operating steps:

- a) The hot plate shall be heated until a steady test temperature is maintained for 5 min. The plate temperature shall be kept within $\pm 15^\circ\text{C}$ of the set-point during the test.
- b) Refrigerant used for the test shall be the nominal composition (NC) in accordance with ISO 817. Refrigerant from the liquid phase shall be trapped between valve 1 and valve 2. Open valve C to spray the liquid refrigerant onto the centre of the hot plate.
- c) Observe and record if ignition (flames) occurs or does not occur within 3 min after release.

NOTE Ignition is considered as being within the chimney above the plate.

Care shall be taken to avoid vapours getting under the insulation, any ignition outside of the chimney is due to ignition on surfaces hotter than the test surface.

- d) A minimum of 5 min of ventilation shall be allowed between runs to clear out reaction products and residual refrigerant.
- e) Perform a minimum of 5 repetitions trials at each temperature being tested.
- f) The temperature of the hot plate shall be set at 800°C . If ignition occurs, then the plate temperature is to be reduced in increments of 20°C until no ignition occurs in five trials. This temperature is to be recorded as the **hot surface ignition temperature**.

KK.4 Test report

The results shall be recorded in a test report. The report shall include all the information necessary for the interpretation of the test and all information required by the method used. The report shall include:

- documentation with the sample identity and composition,
- temperature where ignition did not occur and where ignition did occur if applicable.

The reported **hot surface ignition temperature** shall be the highest temperature with no ignition in five trials.

Annex LL

(Void)

NOTE Annex LL has been replaced by IEC TS 63542:2024.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex MM (normative)

Refrigerant sensor location confirmation test

MM.1 General

This test is applicable to appliances with **refrigerant detection systems** other than remote detection.

The purpose of this test is to demonstrate that the **refrigerant sensor(s)** of the **refrigerant detection system(s)**, where required, will adequately detect refrigerant, in the event of a leak when installed in the location specified by the manufacturer. Compliance will be determined by measurement of the refrigerant concentration in the location of the **refrigerant sensor**.

MM.2 Test methods

MM.2.1 General

The composition of the refrigerant used for the test shall be taken as the nominal composition as specified in Annex BB. Where **LFL** is referenced in this annex, the **LFL** shall be taken at the nominal composition as specified in Annex BB.

The following appliance **operating states** shall be tested:

- fan OFF, and
- fan ON.

During the test, the appliance is modified by introducing a simulated leak through a capillary tube. The simulated leak is applied for 1 min.

A leakage of refrigerant in the **refrigerating system** is simulated at the most unfavourable **potential leak point** as determined in Clause FF.1. An unfavourable **potential leak point** is a **potential leak point** where the path between the leakage point and the point of detection location is more distant or more obstructed. The refrigerant is injected at the most critical point and the most unfavourable direction at a temperature between 15 °C and 35 °C. The capillary tube shall discharge refrigerant into a chamber or similar device which will reduce the refrigerant velocity into the appliance or space.

Care shall be taken that the installation of the capillary tube does not unduly influence the results of the test and that the structure of the appliance does not unduly influence the results of the test.

NOTE The **potential leak point** for fan ON or fan OFF can differ.

MM.2.2 Test with fan OFF

The test shall be performed with the fan integrated into the appliance off.

The leak rate shall be maintained at $\dot{m}_{\text{leak}}$ in g/s:

$$\dot{m}_{\text{leak}} = 4 \times LFL$$

(MM.1)

where

4 is a constant;

$\dot{m}_{\text{leak}}$ is the mass flow rate of the simulated leak in g/s, $\pm 5\%$;

LFL is the **lower flammability limit** in kg/m³.

If the minimum airflow specified by the manufacturer is not less than the minimum airflow specified in GG.2.2, Clause GG.9 or Clause GG.10, as applicable, testing in the fan ON mode is not required.

MM.2.3 Test with fan ON

If the unit has an airflow setting less than the minimum airflow rate as defined in GG.2.2 or Clause GG.9, as applicable, then the fan ON test shall be performed on the highest available airflow setting of the unit below this minimum airflow rate.

For **enhanced tightness refrigerating systems** with A2L refrigerants in compliance with 22.125, if the unit has an airflow setting less than 20/LFL in m³/h, then the fan ON test shall be performed on the highest available airflow setting below 20/LFL in m³/h.

The leak rate shall be maintained at $\dot{m}_{\text{leak}}$ in g/s:

$$\dot{m}_{\text{leak}} = CF \times LFL \times Q \times 1\,000/3\,600, \text{ but not less than } 4 \times LFL \quad (\text{MM.2})$$

where

$\dot{m}_{\text{leak}}$ is the mass flow rate of the simulated leak in g/s, $\pm 5\%$;

CF is the concentration factor with a value of 0,50;

Q is the unit airflow in m³/h;

LFL is the **lower flammability limit** in kg/m³;

1 000 is the conversion factor from kg to g;

3 600 is the conversion factor from h to s.

MM.2.4 Test set-up

The appliance shall be installed according to the instructions. Appliances that can be installed in different positions shall be tested in all positions allowed by the manufacturer. The supply and return openings shall not be covered and the manufacturer's recommended air-filters shall be installed in accordance with the instructions.

The test is conducted in a room that is draught-free and of sufficient size to conduct the test without influencing the results by accumulation of leaked refrigerant into the room during the test.

The minimum room area A_t is:

$$A_t = 1,2 \times \dot{m}_{\text{leak}} / (LFL \times h_t) \quad (\text{MM.3})$$

where

A_t is the minimum room area for the test in m^2 ;

h_t is the height from the floor to the bottom of the unit in the test set-up in metres (m);

$\dot{m}_{leak}$ is the refrigerant leak rate in g/s;

LFL is the **lower flammability limit** in kg/m^3 ;

1,2 is the conversion factor based on limiting the test room concentration to 5 % of LFL at the end of the 60 s refrigerant release at a release rate of $\dot{m}_{leak}$.

MM.2.5 Instrumentation

The instrument used for monitoring the refrigerant gas concentration shall have a fast response to the gas concentration, at least 90 % response within 10 s (time constant 4,3 s) and shall be located as close to the intended **refrigerant sensor** location as possible, but care should be taken not to unduly influence the results of the test.

NOTE An oxygen sensor can be used for monitoring.

The sampling interval shall be 10 s or less.

MM.2.6 Compliance criteria

The measured concentration of refrigerant gas at the location of the **refrigerant detection system refrigerant sensor** shall exceed the alarm set point of the **refrigerant detection system** used within 90 s from the start of the release. Where multiple **refrigerant sensors** are applied with the **refrigerant detection system**, if the concentration at any single **refrigerant sensor** location exceeds the alarm set point of the **refrigerant detection system** used within 90 s from the start of the release, the **refrigerant detection system refrigerant sensor** location shall be considered in compliance.

Annex NN (normative)

Flame arrest enclosure verification test for A2L refrigerants

NN.1 General

Annex NN is applicable to appliances using **A2L refrigerants**.

A flame arrest enclosure is a device or assembly enclosing components with electrical contacts that are made and broken, or similar devices which can become a source of ignition which will withstand an internal ignition of a **A2L refrigerant** vapour which can enter it without suffering damage and without transmission of flame from the internal ignition to an external **A2L refrigerant** vapour of the same refrigerant.

Electrical components enclosed in a flame arrest enclosure in compliance with the test procedures below shall not be considered as a source of ignition.

If all openings in the enclosure comply with Annex JJ, the enclosure is deemed to comply.

NN.2 Test method

NN.2.1 *The test shall be conducted on a single sample enclosure or the complete appliance. The test shall be conducted one time.*

NN.2.2 *Representative electrical components and related wiring as intended in the final end usage in the appliance shall be installed in the enclosure. The enclosure shall be positioned as it would be in the appliance and all construction critical to ensure non-transmission of flames shall be included.*

NN.2.3 *If panels or similar means of access are intended to be opened or removed for routine service and maintenance, the panels shall be removed or opened ten times prior to conducting the test.*

NN.2.4 *Dielectric strength tests in accordance with 16.3 shall be conducted prior to the test.*

NN.2.5 *The ambient test conditions shall be at 32 °C **dry-bulb temperature** and 27 °C **dew point temperature**.*

NN.2.6 *The enclosure shall be filled with and surrounded by a stoichiometric mixture of the intended refrigerant.*

NN.2.7 *The flammable refrigerant vapour inside the enclosure shall be ignited in the most unfavorable position. The ignition shall be provided using a 15 kV source producing a 30 mA spark across a 6,4 mm gap for $0,3 \text{ s} \pm 0,05 \text{ s}$ or equivalent. Ignition of the refrigerant inside the enclosure shall be confirmed visually or by any other method.*

NN.2.8 *Dielectric strength tests in accordance with 16.3 shall be conducted after the test.*

NN.2.9 *The enclosure shall be considered in compliance with Annex NN if all of the following conditions are met:*

- *There shall be no ignition of the refrigerant vapour outside the enclosure.*
- *There shall be no visible signs of damage outside the enclosure.*
- *The dielectric strength after the test shall be in compliance with the requirements of this standard.*
- *The enclosure shall be capable of performing all intended primary safety functions, including protection from hazardous **live parts** and ingress of water, if applicable.*

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex OO

(Void)

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex PP (normative)

Leak detection system confirmation test for flammable refrigerants

PP.1 General

This test is applicable to appliances using **flammable refrigerants** with **leak detection systems** which initiate safety measures upon detection when required according to Annex GG. This test is not applicable to **refrigerant detection systems** using remote **refrigerant sensors**.

The **leak detection system** shall comply with the following:

- for **leak detection systems** using **refrigerant detection systems**, the requirements in Clause PP.2 shall apply;
- for **leak detection systems** using ultrasonic based detection systems, the requirements of Clause PP.2 shall apply;
- for **leak detection systems** using system parameter-based detection systems, the requirements of Clause PP.3 shall apply.

For the low leak rate of PP.2.2.2 and the leak rate of PP.2.2.3 and the small leak orifice of PP.3.2, the actions required by Annex GG shall be completed within 90 s of the initiation of the simulated leak.

For the high leak rate of PP.2.2.2 and the large leak orifice of PP.3.3, the actions required by Annex GG shall be completed within 30 s of the initiation of the simulated leak. For appliances where the release height h_0 as determined in Clause GG.2 is less than 1 m, the actions required by Annex GG shall be completed within 15 s of the initiation of the simulated leak.

EXAMPLE For **circulation airflow** (according to GG.2.3.1 or GG.14.3.1 as applicable), the action is completed when the **circulation airflow** reaches $Q_{\min}$.

PP.2 Test method for leak detection systems using refrigerant detection systems and ultrasonic based detection systems

PP.2.1 Test set-up

PP.2.1.1 General

The appliance is modified by introducing a simulated leak through an orifice or capillary tube, as appropriate. The simulated leak shall be maintained until the actions required by Annex GG are completed.

*A leak shall be simulated at the most unfavourable **potential leak point** as determined in Clause FF.1 from where the leaked refrigerant could then enter an indoor space. An unfavourable **potential leak point** is a **potential leak point** where the path between the **potential leak point** and the point of detection location is more distant or more obstructed. The test shall be conducted at the leak rates defined in PP.2.2 as applicable.*

*The composition of the refrigerant used for the test shall be taken as the nominal composition as specified in Annex BB. Where **LFL** is referenced in Annex PP, the **LFL** shall be taken at the nominal composition as specified in Annex BB.*

NOTE Sound and thermal insulation can affect the result of ultrasonic detection.

PP.2.1.2 Simulation of leak

A leakage of refrigerant in the **refrigerating system** is simulated by injecting vapour at the **potential leak points** identified in PP.2.1.1.

The refrigerant shall be released such that the pressure at the inlet to the release orifice is not less than 300 kPa (gauge) in order to achieve choked flow.

Care shall be taken that the installation of the orifice or capillary does not unduly influence the results of the test.

PP.2.1.3 Installation conditions

Appliances that can be installed in different positions shall be tested in all positions allowed by the instructions. The supply and return openings shall not be covered and the recommended air-filters shall be installed in accordance with the instructions.

PP.2.1.4 Test room

The test is conducted in a room that is of sufficient size to conduct the test without influencing the results by accumulation of leaked refrigerant into the room during the test.

The minimum room area A_t is:

$$A_t = 2,4 \times \dot{m}_{\text{leak}} / (\text{LFL} \times h_t) \quad (\text{PP.1})$$

where

A_t is the minimum room area for the test in m^2 ;

h_t is the height from the floor to the bottom of the unit in the test set-up in m;

$\dot{m}_{\text{leak}}$ is the leak rate in g/s;

LFL is the **lower flammability limit**, in kg/m^3 ;

2,4 is the conversion factor based on limiting the test room concentration to 5 % of LFL at the end of a 120 s refrigerant release at a release rate of $\dot{m}_{\text{leak}}$.

PP.2.2 Test procedure

PP.2.2.1 General

During this test, following appliance **operating states** shall be tested:

- fan OFF, and
- fan ON.

If the actions required by Annex GG in the event of detection of a leak are **circulation airflow** and/or mechanical ventilation, and the minimum airflow specified by the manufacturer is not less than the minimum airflow specified in Annex GG, testing in the fan ON mode is not required.

PP.2.2.2 Fan OFF

The low leak rate shall be:

$$\dot{m}_{\text{leak}} = 4 \times \text{LFL} \quad (\text{PP.2})$$

where

$\dot{m}_{\text{leak}}$ is the leak rate in g/s;

4 is a constant;

LFL is the **lower flammability limit** in kg/m³.

The high leak rate shall be:

$$\dot{m}_{\text{leak}} = 4,17 \times m_c \quad (\text{PP.3})$$

where

$\dot{m}_{\text{leak}}$ is the leak rate in g/s;

4,17 is a constant;

m_c is the **refrigerant charge** in kg.

NOTE 4,17 is 1 000/240 and is based on a 4 min leak of m_c and conversion from units of kg to g.

PP.2.2.3 Fan ON**PP.2.2.3.1 General**

Fan ON test shall be conducted if the actions required by Annex GG in the event of detection of a leak are **circulation airflow** and/or mechanical ventilation.

If the minimum airflow specified by the manufacturer is not less than the minimum airflow specified in Annex GG, then the fan ON test is not required.

If the minimum airflow specified is less than the minimum airflow specified in Annex GG, then the fan ON test shall be performed on the highest available airflow setting of the unit below this minimum airflow rate.

PP.2.2.3.2 Enhanced tightness refrigerating systems

For **enhanced tightness refrigerating systems** with **A2L refrigerants** in compliance with 22.125, if the unit has an airflow setting less than 20/LFL in m³/h, then the fan ON test shall be performed on the highest available airflow setting below 20/LFL in m³/h.

For **enhanced tightness refrigerating systems** with A2 and A3 refrigerants, the simulated leak mass flow shall be:

$$\dot{m}_{\text{leak}} = \left[\frac{Q h_0^{1/4} [\text{LFL} \times (1 - \text{CF})]^{5/8}}{3\,600 \times 5Y \sqrt{A_0}} \right]^{4/3} \times 10^3 \quad (\text{PP.4})$$

where

Q	is the unit airflow volume in m^3/h ;
3 600	is a constant to convert h to s ;
A_o	is the airflow discharge area of the appliance in m^2 . The value is the nominal face area of the outlet. The grille area shall not be deducted;
Y	is a constant, if there are leak sources outside the unit $Y = 1,5$, otherwise $Y = 1$;
$\dot{m}_{leak}$	is the refrigerant leak rate in g/s ;
h_0	is the release height, the vertical distance in metres from the floor to the point of release when the appliance is installed (see Figure GG.3) according to GG.2.1 but not less than 0,6 m and not to exceed 2,2 m;
LFL	is the lower flammability limit in kg/m^3 ;
CF	is a concentration factor as selected for GG.14.3.1.

PP.2.2.3.3 Non-enhanced tightness refrigerating systems

For non-enhanced tightness refrigerating systems with A2L refrigerants the leak rate shall be maintained at:

$$\dot{m}_{leak} = CF \times LFL \times Q \times 1\,000/3\,600, \text{ but not less than } 4 \times LFL \quad (PP.5)$$

where

$\dot{m}_{leak}$	is the refrigerant leak rate in g/s ;
CF	is the concentration factor with a value of 0,50;
LFL	is the lower flammability limit in kg/m^3 ;
Q	is the unit airflow volume in m^3/h ;
1 000	is a constant to convert kg to g ;
3 600	is a constant to convert h to s .

For non-enhanced tightness refrigerating systems with A2 and A3 refrigerants, the simulated leak mass flow shall be:

$$\dot{m}_{leak} = \frac{1\,000 \times Q \times m_c^{1/4} \times LFL^{3/4}}{3\,600 \times 8Y \sqrt{A_o}} \left(\frac{1 - CF}{CF^{1/4}} \right) \quad (PP.6)$$

where

$\dot{m}_{leak}$	is the refrigerant leak rate in g/s ;
Q	is the unit airflow volume in m^3/h ;
1 000	is a constant to convert kg to g ;
3 600	is a constant to convert h to s ;
8	is a constant;
A_o	is the airflow discharge area of the appliance in m^2 . The value is the nominal face area of the outlet. The grille area shall not be deducted;
m_c	is the actual refrigerant charge amount in the system in kg ;
LFL	is the lower flammability limit in kg/m^3 ;
Y	is a constant, if there are leak sources outside the unit $Y = 1,5$, otherwise $Y = 1$;

CF is a concentration factor as selected in GG.2.3.1.

PP.3 Test method for leak detection systems using system parameter based detection

PP.3.1 The appliance is modified by introducing a leak orifice in the system. The leak shall continue until the actions required by Annex GG are completed.

The orifice shall be positioned at the least favourable location of the refrigerant-containing parts of the appliance intended to be located indoors. The test shall be conducted with each of the leak orifices defined in PP.3.2 and PP.3.3.

The system shall be charged with the refrigerant type and amount as stated in the instructions.

The composition of the refrigerant used for the test shall be taken as the nominal composition as specified in Annex BB. Where **LFL** is referenced in this annex, the **LFL** shall be taken at the nominal composition as specified in Annex BB.

PP.3.2 The small leak orifice to within $\pm 0,1 \text{ mm}^2$ shall be:

$$A_o = 4 \times \text{LFL} / 1,7 \quad (\text{PP.7})$$

where

A_o is the orifice area in mm^2 and shall be no less than $0,1 \text{ mm}^2$;

4 is a constant;

1,7 is a nominal mass flux in $\text{g}/(\text{s mm}^2)$;

LFL is the lower flammability limit, in kg/m^3 .

The length of the orifice bore shall be no longer than 1 mm.

PP.3.3 The large leak orifice to within $\pm 0,1 \text{ mm}^2$ shall be:

$$A_o = 4 \times m_c / 0,8 \quad (\text{PP.8})$$

where

A_o is the orifice area in mm^2 and shall be no less than $0,1 \text{ mm}^2$;

4 is a constant;

0,8 is a nominal mass flux in $\text{g}/(\text{s mm}^2)$;

m_c is the **refrigerant charge** in kg.

The length of the orifice bore shall be no longer than 1 mm.

PP.3.4 The system shall be operated in the following operating states as appropriate:

- compressor off with indoor temperature of 27°C and outdoor temperature of 35°C , with indoor fan ON;
- compressor off with indoor temperature of 27°C and outdoor temperature of 35°C , with indoor fan OFF;

c) *cooling mode with*

- *the compressor running at maximum speed at the specified temperature, and*
- *highest outdoor air temperature and highest airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate, and*
- *highest indoor air temperature and highest indoor fan airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate;*

d) *heating mode with*

- *the compressor running at maximum speed at the specified temperature, and*
- *highest outdoor air temperature and highest airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate, and*
- *highest indoor air temperature and highest indoor fan airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate.*

NOTE The fan can have a different maximum speed depending on the operating state and working temperature; the highest speed in that condition is relevant.

The test is for the condition where the leak orifice is positioned at the most critical location, being the one that yields the greatest time before the actions required by Annex GG are completed.

Care shall be taken that the installation of the orifice does not unduly influence the results of the test.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex QQ (normative)

Methods for determining releasable charge

QQ.1 General

The **releasable charge** m_{rl} shall be determined in each **operating state** in accordance with Annex QQ.

The **operating state** to be applied for a **refrigerating system** which is not a **releasable charge limited system** is unit powered in standby mode, indoor and outdoor ambient at 23 °C. The crankcase heater, if any, shall be energized.

NOTE 1 It can be necessary to bypass a **thermostat** to ensure the crankcase heater is energized.

For a **releasable charge limited system**, the test conditions of Clause QQ.6 apply.

NOTE 2 When safety shut-off valves are applied, both sides of the valve can be potential leak positions.

For **refrigerating systems** that comply with the requirements of Clause GG.10 and have **releasable charge limited systems** using **safety shut-off valves**, the **releasable charge** shall be determined by Clause QQ.2, Clause QQ.3, or Clause QQ.4.

NOTE 3 The **releasable charge** can be determined by calculation, measurement or a combination thereof, depending on the product and application. For large or complicated **refrigerating systems**, it can be impossible or impractical to execute the test of Clause QQ.2, due to the large number of configurations or when leaking of the refrigerant into the atmosphere cannot be accepted during testing.

For all other **refrigerating systems**, the **releasable charge** shall be determined by Clause QQ.2.

QQ.2 Determination of releasable charge by a simulated leak

QQ.2.1 Test set-up

The appliance shall be installed within the test facility according to the instructions.

If the appliance can be installed with additional pipework, the pipework shall be installed which results in the largest **releasable charge**.

NOTE 1 The largest **releasable charge** is typically at the largest pipe diameter and length specified by the instructions.

The **refrigerating system** shall be evacuated prior to each test and charged with the **refrigerant charge** according to the instructions.

The evacuation process should be sustained for a sufficiently long time to ensure any refrigerant absorbed in the oil has been removed.

All **potential leak points** as determined in Clause FF.1 from where leaked refrigerant could then enter an indoor space shall be considered for determining the **releasable charge**.

A leak orifice shall be installed at a location in the **refrigerating system** that would result in the greatest amount of refrigerant entering the indoor space. A valve to enable opening and closing the orifice shall be installed between the position where a leak could occur and the orifice. The distance from the position where a leak could occur to the orifice shall be less than 200 mm. The piping shall be no less than 4 mm internal diameter.

NOTE 2 It can be necessary to consider multiple locations.

The test is for the condition where the leak orifice is positioned at the most critical location, being the one that yields the greatest **releasable charge**.

For a **releasable charge limited system**, the test shall be repeated with each of the following three orifice sizes:

- small orifice size according to PP.3.2;
- medium orifice size 1,5 mm ± 0,15 mm diameter;
- large orifice size 2,5 mm ± 0,25 mm diameter.

For other **refrigerating systems**, the test shall be carried out with the large orifice size of 2,5 mm ± 0,25 mm diameter.

The length of the orifice bore shall be no longer than 1 mm.

NOTE 3 Small orifice size is based on a 15 g/min leak rate of R290 vapour at saturation pressure corresponding to 10 °C (under choked flow). It is assumed that a system leaking at this flow rate is unlikely to lead to accumulation of dangerous concentrations.

NOTE 4 Large orifice size is based on an R-290 system comprising a mass of m_2 releasing its entire charge in approximately 4 min at saturation pressure corresponding to 10 °C (under choked flow).

The **refrigerating system** shall be tested under the relevant **operating state** and under the conditions which result in the greatest amount of **refrigerant charge** being released.

QQ.2.2 Test method

The **refrigerating system** is operated according to the **operating state** of the appliance.

The test shall be repeated at least three times. The **releasable charge** m_{rl} shall be three standard deviations above the mean of the test results.

The refrigerant is released directly into a test room or directly vented to the outside, as appropriate for the test.

The appliance **refrigerating system** shall be stabilized in the **operating state** and test conditions for 30 min prior to opening the leak orifice.

For systems which are not **releasable charge limited systems**, the system shall be turned off immediately before starting the test.

The leak orifice is opened for a duration of 4 h, after which time the leak orifice valve shall be closed.

The **refrigerating system** shall then be evacuated and the refrigerant removed shall be measured.

The weight of the refrigerant removed at the end of the test is the retained mass (m_{ret}). The **releasable charge** (m_{rl}) is then determined by:

$$m_{\text{rl}} = m_{\text{c}} - m_{\text{ret}} \quad (\text{QQ.1})$$

where

m_{rl} is the **releasable charge** in kg;

m_{c} is the **refrigerant charge** in kg;

m_{ret} is the refrigerant retained in the system at the end of the leak in kg.

QQ.3 Determination of releasable charge by a simulated leak for refrigerating systems complying with Clause GG.10

QQ.3.1 General

The **releasable charge**, m_{rl} , shall be determined by the test of QQ.3.2 and QQ.3.3.

QQ.3.2 Test set-up

NOTE 1 This method is similar to Clause QQ.2, only modified to allow evaluation of systems with refrigerants that cannot be vented into atmosphere.

Install the appliance, including **safety shut-off valves**, according to the instructions, in the smallest room as specified by the instructions, with the set-up that will create the largest **releasable charge** for that room.

NOTE 2 A test set-up with indoor units with a larger inner volume can be representative for units with a smaller inner volume. A test set-up with piping with a larger inner volume can be representative for piping with a smaller inner volume.

NOTE 3 It is possible for the instructions to cover different room sizes for different set-ups; if so, each set-up will be considered separately.

The **refrigerating system** shall be evacuated prior to each test, and then charged with refrigerant equal to m_{c} , where m_{c} is the **refrigerant charge** in kg.

A calibrated leak opening shall be installed in the **refrigerating system** that would result in the greatest amount of refrigerant released in the occupied space. A valve to enable opening and closing of the calibrated leak opening shall be installed between the appliance and the calibrated leak opening. The calibrated leak shall be at the point in the circuit that has the highest saturated pressure in the indoor unit during steady state operation.

The calibrated leak opening shall vent into a volume at atmospheric pressure.

NOTE 4 The volume can be a room or a pressure vessel kept at atmospheric pressure; this is to avoid that the refrigerant is released into the atmosphere.

The calibrated opening shall be a capillary or orifice that leaks at 2,8 g/s from saturated liquid at a saturated pressure of 63 °C.

QQ.3.3 Test method

The **refrigerating system** shall operate according to the **operating state** until steady state is reached for at least 30 min, prior to opening the valve of the calibrated leak opening.

NOTE 1 The same applies for standstill condition.

The test shall be repeated at least three times and the **releasable charge** shall be two standard deviations above the mean result.

NOTE 2 The calculation of the mean value and the standard deviations apply to each **operating state** separately.

The valve to the calibrated leak opening is opened.

The **refrigerating system** shall operate normally for t_{r1} time with the calibrated leak open, where t_{r1} is the time before the leak is detected as determined in Clause QQ.5.

After the t_{r1} time, the **refrigerant charge limited system** shall simulate a detected leak.

NOTE 3 This can be done by any method, for example putting the refrigerant sensor in the refrigerant concentration above the alarm set point of the sensor, C_{set} .

After the **safety shut-off valves** are closed, the remaining charge m_{rm} contained in the part of the **refrigerating system** which is closed by the **safety shut-off valves** is measured.

The **releasable charge** (in kg) is:

$$m_{rl} = m_c - m_{rm} \quad (\text{QQ.2})$$

where

m_c is the **refrigerant charge** in kg;

m_{rm} is the remaining charge in kg.

QQ.4 Determination of releasable charge by calculation and test for refrigerating systems complying with Clause GG.10

QQ.4.1 General

The **releasable charge**, m_{rl} , shall be calculated as the sum of the refrigerant released in the separate stages according to the following:

$$m_{rl} = t_{r1} \times 0,002\ 8 + m_{r2} + m_{r3} \quad (\text{QQ.3})$$

where

t_{r1} is the time before the leak is detected as determined in Clause QQ.5 in s;

m_{r2} is the charge released between detection and closing the **safety shut-off valves** as determined in QQ.4.2 in kg;

m_{r3} is the refrigerant released after closing the **safety shut-off valves** in part of the system that can leak into the occupied space as determined in QQ.4.3 in kg;

0,002 8 is the assumed leak rate in kg/s.

NOTE The **releasable charge** considers the following: Refrigerant release before the leak is detected, refrigerant release between the detection and closing of the **safety shut-off valves** and refrigerant release afterwards.

QQ.4.2 Refrigerant release between detection and closing the safety shut-off valves

The refrigerant amount released between the **leak detection system** giving an output signal and closing the **safety shut-off valves**, m_{r2} , shall be determined as:

$$m_{r2} = 0,002\ 8 \times t_{cl} \quad (\text{QQ.4})$$

where

t_{cl} is the time from the **leak detection system** giving an output signal to the **safety shut-off valves** being fully closed in s;

0,002 8 is the assumed leak rate in kg/s.

Compliance is checked by inspection and test to determine the value of t_{cl} .

QQ.4.3 Determination of m_{r3} **QQ.4.3.1 General**

To determine the **releasable charge** after closing the shut-off valves, m_{r3} , which can leak into the occupied space, determine the **releasable charge** for each part (unit or piping), $m_{r3,i}$, that can leak into the occupied space after closing the shut-off valves by one of the following methods:

- determine apparent density, $\rho_{part,i}$, by measuring the pressure according to QQ.4.3.2;
- determine apparent density, $\rho_{part,i}$, by applying default values according to QQ.4.3.3;
- determine apparent density, $\rho_{part,i}$, according to QQ.4.3.4.

NOTE 1 *The apparent density is the total mass of refrigerant in the part being evaluated divided by the total free internal volume of that part.*

NOTE 2 *These methods can be combined for evaluating each part.*

A part shall be the piping or the indoor unit between the field connection points.

NOTE 3 *The apparent densities that are determined in a part can be used to calculate the **releasable charge** after closing the shut-off valves for different configurations. For instance, the apparent density determined in the piping can be used for the calculation with different piping lengths that operate under the same condition.*

The **releasable charge** after closing the shut-off valves, m_{r3} , shall be the sum of the charge of each part that can leak into the occupied space after closing the shut-off valves:

$$m_{r3} = \sum V_{part,i} \times \rho_{part,i} \quad (\text{QQ.5})$$

where

$V_{part,i}$ is the free internal volume in the evaluated part i in m³;

$\rho_{part,i}$ is the apparent density of refrigerant in the evaluated part i in kg/m³.

QQ.4.3.2 Determine apparent density, $\rho_{part,i}$, by measuring the pressure

To determine the apparent density, $\rho_{part,i}$, of the **releasable charge** after closing the shut-off valves for the evaluated part of the system by measuring the pressure, the following procedure shall be applied.

The appliance shall be installed according to the manufacturer's instructions. The most unfavourable combination of test samples shall be chosen.

NOTE The most unfavourable combination is the set-up that will create the highest apparent density.

*For the test in cooling or heating mode, the system is operated according to the condition specified in Clause QQ.6. The **refrigerating system** shall operate according to the **operating state** until steady state is reached for at least 30 min.*

For the test in standby mode, the system shall be stopped for 8 h after the cooling operation according to the condition specified in Clause QQ.6 for 30 min.

The refrigerant state (liquid, gas or mixture) for the evaluated part of the system shall be determined.

The pressure shall be measured at the refrigerant entering side for units and piping.

The apparent density for the evaluated part of the system, $\rho_{\text{part},i}$, shall be determined as:

- *for liquid piping: the density of saturated liquid at the pressure that is measured;*
- *for gas piping: the density of saturated gas at the pressure that is measured;*
- *for piping containing mixture of gas and liquid: the density of saturated liquid at the pressure that is measured;*
- *for indoor units: the density of saturated liquid at the pressure that is measured.*

QQ.4.3.3 Determine apparent density, $\rho_{\text{part},i}$, by default values

When no test is executed, the following method shall be applied.

The refrigerant state (liquid, gas or mixture) for the evaluated part of the system shall be determined.

The apparent density for the evaluated part of the system, $\rho_{\text{part},i}$, shall be determined as:

- *for liquid piping: the density of saturated liquid at 10 °C;*
- *for gas piping: the density of saturated gas at 42 °C;*
- *for piping containing mixture of gas and liquid: the density of saturated liquid at 10 °C;*
- *for indoor units: the density of saturated liquid at 10 °C.*

QQ.4.3.4 Determine apparent density, $\rho_{\text{part},i}$, by measuring the recovered refrigerant amount from the unit or piping

To determine the apparent density, $\rho_{\text{part},i}$, of the releasable refrigerant after closing the shut-off valves for the evaluated indoor unit or piping by measuring the recovered refrigerant amount, the following procedure shall be applied.

*The appliance including **safety shut-off valves** shall be installed according to the manufacturer's instructions. The most unfavourable combination of test samples shall be chosen.*

NOTE 1 If in doubt, multiple samples can be measured.

Shut-off valves for testing shall be installed upstream and downstream of the part where the apparent density is measured. Shut-off valves for testing shall be of the same type as the **safety shut-off valves** used for the appliances. The action to shut-off shall be made in accordance with the **normal operation** of the **safety shut-off valves**.

For the test in cooling or heating mode, the system is operated according to the condition specified in Clause QQ.6. The **refrigerating system** shall operate according to the **operating state** until steady state is reached for at least 30 min prior to closing the shut-off valves for testing.

For the test in standby mode, the system shall be operated in cooling mode according to the condition specified in Clause QQ.6 for 30 min, and then stopped for 8 h.

The refrigerant containing part of the unit which is to be evaluated is shut off completely from upstream and downstream by shut-off valves. The shut-off valves used for testing shall close simultaneously when the last **safety shut-off valve** closes during the safety shut-off sequence.

The part being evaluated shall then be evacuated and the recovered refrigerant amount, m_{rm} , shall be measured.

The test shall be repeated at least three times and the measured refrigerant amount, m_{rm} , shall be two standard deviations above the mean result.

NOTE 2 The calculation of the mean value and the standard deviations apply to each **operating state** separately.

The apparent density, $\rho_{part,i}$, of the evaluated part i is:

$$\rho_{part,i} = m_{rm} / V_{part,i} \quad (QQ.6)$$

where

m_{rm} is the measured refrigerant amount in the evaluated part i in kg;

$V_{part,i}$ is the internal free volume in the evaluated part i in m³.

QQ.5 Time before the leak is detected, t_{r1}

QQ.5.1 General

The time before a leak is detected, t_{r1} , in seconds (s) is determined by one of the following:

- where the **refrigerant sensor** location is in compliance with Annex MM when tested at the maximum airflow for the **operating state**, QQ.5.2 applies;
- where the **leak detection system** is in compliance with Annex PP, QQ.5.2 applies;
- for all other cases, QQ.5.3 applies.

QQ.5.2 Determination of t_{r1} by default time

The time for the **leak detection system** to give an output signal, t_{r1} , shall be 120 s.

NOTE 120 s = 90 s + 30 s. 90 is the time delay in seconds specified in Annex MM, 30 is the maximum response time of the **refrigerant sensor** in seconds specified in IEC TS 63542:2024. The time delay in seconds specified in Annex PP is 90 s, which is less than the 120 s.

QQ.5.3 Determination of t_{r1} based on effective room concentration

The time for the **refrigerant detection system** to give an output signal, t_{r1} , in seconds shall be determined as:

$$t_{r1} = (H_r \times A_{\min} \times LFL \times C_{\text{set}} / 0,002\ 8) + 30 \quad (\text{QQ.7})$$

where

H_r is the effective height of the indoor unit as determined in GG.10.3 in m;

$A_{\min}$ is the required minimum room area in m²;

LFL is the **lower flammability limit** in kg/m³;

C_{set} is the alarm set point of the sensor in % of **LFL**, including the sensor tolerances, that results in the highest C_{set} ;

0,002 8 is the assumed leak rate in kg/s;

30 is a constant.

NOTE 1 0,002 8 is the release rate in g/s for the **enhanced tightness refrigerating systems** under Clause GG.10, and 30 is the maximum response time of the **refrigerant sensor** in seconds specified in IEC TS 63542:2024.

NOTE 2 *Detection is assumed when the room concentration reaches the alarm set point of the **refrigerant detection system**. Installing the appliance in a room larger than $A_{\min}$ will result in an overall safer situation, even though t_{r1} will be underestimated.*

NOTE 3 This calculation method is typically used for remote **refrigerant sensors** and for appliances where there is too much airflow to detect a leak during the tests of Annex MM or Annex PP.

NOTE 4 *It is assumed that the **refrigerant sensor** is able to detect the refrigerant concentration in the room where it is installed, for instance by being installed in the airstream of the unit or close to the floor.*

QQ.6 Test conditions for releasable charge limited systems

For a **releasable charge limited system**, the following **operating states** and conditions specified in the instructions shall be applied as applicable:

- a) Compressor off with indoor temperature 27 °C and outdoor temperature 35 °C, with indoor fan ON;
- b) Compressor off with indoor temperature 27 °C and outdoor temperature 35 °C, with indoor fan OFF;
- c) Cooling mode with
 - the compressor running at maximum speed at the specified temperature, and
 - highest outdoor air temperature and highest airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate, and
 - highest indoor air temperature and highest indoor fan airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate;
- d) Heating mode with
 - the compressor running at maximum speed at the specified temperature, and
 - highest outdoor air temperature and highest airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate, and
 - highest indoor air temperature and highest indoor fan airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate.

NOTE The fan can have a different maximum speed depending on the operating state and working temperature; the highest speed in that condition is relevant.

Bibliography

IEC 60050-482:2004, *International Electrotechnical Vocabulary (IEV) – Part 482: Primary and secondary cells and batteries*

IEC 60050-845, *International Electrotechnical Vocabulary (IEV) – Lighting*

IEC 60079-1:2014, *Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d"*

IEC 60079-11:2011, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"*

IEC 60079-15:2017, *Explosive atmospheres – Part 15: Equipment protection by type of protection "n"*

IEC 60079-29-1:2016, *Explosive atmospheres – Part 29-1: Gas detectors – Performance requirements of detectors for flammable gases*
IEC 60079-29-1:2016/AMD1:2020

IEC 60086-1, *Primary batteries – Part 1: General*

IEC 60086-2, *Primary batteries – Part 2: Physical and electrical specifications*

IEC 60335-2-21, *Household and similar electrical appliances – Safety – Part 2-21: Particular requirements for storage water heaters*

IEC 60335-2-29, *Household and similar electrical appliances – Safety – Part 2-29: Particular requirements for battery chargers*

IEC 60335-2-88, *Household and similar electrical appliances – Safety – Part 2-88: Particular requirements for humidifiers intended for use with heating, ventilation, or air-conditioning systems*

IEC 60364 (all parts), *Low voltage electrical installations*

IEC 60601 (all parts), *Medical electrical equipment*

IEC 60721-2-1, *Classification of environmental conditions – Part 2-1: Environmental conditions appearing in nature – Temperature and humidity*

IEC 60730 (all parts), *Automatic electrical controls*

IEC 60745 (all parts), *Hand-held motor-operated electric tools – Safety*

IEC 60950-1, *Information technology equipment – Safety – Part 1: General requirements*

IEC 60998-2-1, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-1: Particular requirements for connecting devices as separate entities with screw-type clamping units*

IEC 60998-2-2, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-2: Particular requirements for connecting devices as separate entities with screwless-type clamping units*

IEC 61000-3-2, *Electromagnetic compatibility (EMC) – Part 3-2: Limits – Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)*

IEC 61000-3-3, *Electromagnetic compatibility (EMC) – Part 3-3: Limits – Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection*

IEC 61029 (all parts), *Safety of transportable motor-operated electric tools*

IEC 61508-3:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 3: Software requirements*

IEC 61508-7:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 7: Overview of techniques and measures*

IEC 62280, *Railway applications – Communication, signalling and processing systems – Safety related communication in transmission systems*

IEC 62368-1, *Audio/video, information and communication technology equipment – Part 1: Safety requirements*

IEC 62841 (all parts), *Electric motor-operated hand-held tools, transportable tools and lawn and garden machinery – Safety*

CISPR 11, *Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*

CISPR 14-1, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 1: Emission*

CISPR 14-2, *Electromagnetic compatibility – Requirements for household appliances, electric tools and similar apparatus – Part 2: Immunity – Product family standard*

ISO 527-3, *Plastics – Determination of tensile properties – Part 3: Test conditions for films and sheets*

ISO 845, *Cellular plastics and rubbers – Determination of apparent density*

ISO 1043-1, *Plastics – Symbols and abbreviated terms – Part 1: Basic polymers and their special characteristics*

ISO 17584, *Refrigerant properties*

ISO 22712, *Refrigerating systems and heat pumps – Competence of personnel*

ISO/IEC 9796 (all parts), *Information technology – Security techniques – Digital signature scheme giving message recovery*

ISO/IEC 9797 (all parts), *Information technology – Security techniques – Message Authentication Codes (MACs)*

ISO/IEC 9798 (all parts), *IT Security techniques – Entity authentication*

ISO/IEC 10118 (all parts), *IT Security techniques – Hash-functions*

ISO/IEC 11770 (all parts), *IT Security techniques – Key management*

ISO/IEC 14888 (all parts), *IT Security techniques – Digital signatures with appendix*

ISO/IEC 15946 (all parts), *Information technology – Security techniques – Cryptographic techniques based on elliptic curves*

ISO/IEC 18033 (all parts), *Information technology – Security techniques – Encryption algorithms*

ISO/IEC 19772 (all parts), *Information technology – Security techniques – Authenticated encryption*

ISO/IEC 29192 (all parts), *Information technology – Security techniques – Lightweight cryptography*

IEC Guide 104, *The preparation of safety publications and the use of basic safety publications and group safety publications*

IEC Guide 108, *Guidelines for ensuring the coherence of IEC publications – Horizontal functions, horizontal publications and their application*

IEC Guide 110, *Home control systems – Guidelines relating to safety*

IEC Guide 117, *Electrotechnical equipment – Temperatures of touchable hot surfaces*

ISO/IEC Guide 14, *Products and related services – Information for consumers*

ISO/IEC Guide 37, *Instructions for use of products by consumers*

ISO/IEC Guide 50, *Safety aspects – Guidelines for child safety in standards and other specifications*

ISO/IEC Guide 51, *Safety aspects – Guidelines for their inclusion in standards*

ISO/IEC Guide 71, *Guide for addressing accessibility in standards*

API recommended practice 2216 Third Edition, December 2003, *"Ignition risk of Hydrocarbon liquids and vapors by hot surface in the open air" API recommended practice 2216 Third Edition, December 2003*

ASTM E659, *Standard Test Method for Autoignition Temperature of Chemicals*

ASTM D4728-17, *Standard Test Method for Random Vibration Testing of Shipping Containers*

ASTM D6668, *Standard Test Method for Discrimination Between Flammability Ratings of F = 0 and F = 1*

LEMMON, E.W., BELL, I.H., HUBER, M.L., McLINDEN, M.O. *NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP, Version 10.0, National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg, 2018*

NFPA 921, *Guide for fire and explosion investigations (2004) Section 25.4.3.2 "Hot surface ignition of flammable and combustible liquids" Scott Davis, Dylan Chavez and Harri Kytomaa, Exponent, SAE technical paper series 2006-01-1014*

Index of defined terms

accessible part	3.6.3	off position	3.8.2
all-pole disconnection	3.8.1	outlet load	3.1.12
authentication	U.1.1.1		
authorization	U.1.1.2	PTC heating element	3.8.4
		portable appliance	3.5.1
basic insulation	3.3.1	protective device	3.7.6
battery	3.6.9	protective electronic circuit	3.9.3
battery-operated appliance	3.5.9	protective extra-low voltage circuit	3.4.4
battery system	3.10.1	protective impedance	3.3.6
built-in appliance	3.5.5	public network	3.11.3
cell	3.6.8	rated current	3.1.6
charging system	3.10.2	rated frequency	3.1.7
class 0 appliance	3.3.7	rated frequency range	3.1.8
class 0I appliance	3.3.8	rated impulse voltage	3.1.10
class I appliance	3.3.9	rated power input	3.1.4
class II appliance	3.3.10	rated power input range	3.1.5
class III appliance	3.3.12	rated voltage	3.1.1
class II construction	3.3.11	rated voltage range	3.1.2
class III construction	3.3.13	reinforced insulation	3.3.4
clearance	3.3.14	remote communication	3.11.4
combined appliance	3.5.8	remote operation	3.11.5
creepage distance	3.3.15	room temperature	3.8.6
cryptographic technique	U.1.1.3		
		safety extra-low voltage	3.4.2
dangerous malfunction	3.1.11	safety isolating transformer	3.4.3
data integrity protection	U.1.1.4	self-resetting thermal cut-out	3.7.4
detachable battery	3.6.10	separable battery	3.6.11
detachable part	3.6.2	small part	3.6.6
detachable power supply part	3.6.7	specified operating region for charging	3.10.3
double insulation	3.3.3	stationary appliance	3.5.3
		supplementary insulation	3.3.2
electronic circuit	3.9.2	supply cord	3.2.3
electronic component	3.9.1	supply leads	3.2.1
entity	3.11.1		
extra-low voltage	3.4.1	temperature limiter	3.7.2
		thermal cut-out	3.7.3
fixed appliance	3.5.4	thermal link	3.7.7
fully charged	3.10.6	thermostat	3.7.1
fully discharged	3.10.7	tool	3.6.5
functional insulation	3.3.5	type X attachment	3.2.4
		type Y attachment	3.2.5
hand-held appliance	3.5.2	type Z attachment	3.2.6
heating appliance	3.5.6		
		upper limit charging voltage	3.10.4
integral battery	3.6.12	user maintenance	3.8.5
interconnection cord	3.2.2		
intentionally weak part	3.7.8	venting	3.10.5
		visibly glowing heating element	3.8.3
live part	3.6.4		
		working voltage	3.1.3
message	3.11.2		
motor-operated appliance	3.5.7		
non-detachable part	3.6.1		
non-rechargeable battery	B.3.6.1		
non-self-resetting thermal cut-out	3.7.5		
normal operation	B.3.1.1; 3.1.9		

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Household and similar electrical appliances – Safety –
Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and
dehumidifiers**

**Appareils électrodomestiques et analogues – Sécurité –
Partie 2-40: Exigences particulières pour les pompes à chaleur électriques, les
climatiseurs et les déshumidificateurs**

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	8
1 Scope.....	9
2 Normative references	10
3 Terms and definitions	11
4 General requirement.....	19
5 General conditions for the tests	19
6 Classification	20
7 Marking and instructions.....	20
8 Protection against access to live parts.....	26
9 Starting of motor-operated appliances	26
10 Power input and current.....	26
11 Heating.....	26
12 Charging of metal-ion batteries	29
13 Leakage current and electric strength at operating temperature.....	29
14 Transient overvoltages	29
15 Moisture resistance	30
16 Leakage current and electric strength	31
17 Overload protection of transformers and associated circuits	31
18 Endurance	31
19 Abnormal operation	31
20 Stability and mechanical hazards.....	38
21 Mechanical strength	38
22 Construction	40
23 Internal wiring.....	53
24 Components	53
25 Supply connection and external flexible cords	54
26 Terminals for external conductors.....	54
27 Provision for earthing	55
28 Screws and connections	55
29 Clearances, creepage distances and solid insulation	55
30 Resistance to heat and fire	55
31 Resistance to rusting	56
32 Radiation, toxicity and similar hazards.....	57
Annexes	63
Annex D (normative) Thermal motor protectors	63
Annex I (normative) Motors having basic insulation that is inadequate for the rated voltage of the appliance	63
Annex AA (informative) Examples for operating temperatures of the appliance	64
Annex BB (normative) Selected information about refrigerants.....	65
Annex CC (informative) Transportation, marking and storage for units that employ flammable refrigerants	69

Annex DD (normative) Requirements for installation, service, maintenance and repair, and decommissioning instructions of appliances using flammable refrigerants	70
Annex EE (normative) Pressure tests.....	80
Annex FF (normative) Leak simulation tests.....	82
Annex GG (normative) Charge limits, ventilation requirements and requirements for secondary circuits	84
Annex HH (informative) Competence of service personnel	119
Annex II (Void).....	122
Annex JJ (normative) Allowable openings of relays and similar components to prevent ignition of A2L refrigerants	123
Annex KK (normative) Test method for hot surface ignition temperature for A2L	125
Annex LL (Void).....	129
Annex MM (normative) Refrigerant sensor location confirmation test	130
Annex NN (normative) Flame arrest enclosure verification test for A2L refrigerants	133
Annex OO (Void)	135
Annex PP (normative) Leak detection system confirmation test for flammable refrigerants	136
Annex QQ (normative) Methods for determining releasable charge	142
Bibliography.....	150
Figure 101 – Example of label for field charged units.....	58
Figure 102 – Arrangement for heating test of appliances with supplementary air heater.....	60
Figure 103 – Supply circuit for locked-rotor test of a motor of the single-phase type	61
Figure 104 – Power spectral density profile for vibration test in 21.101	61
Figure 105 – Dimensional details for the weight in the area of the pressure ball.....	61
Figure 106 – Measurement before and after the test	62
Figure GG.1 – Unventilated area.....	115
Figure GG.2 – Mechanical ventilation	116
Figure GG.3 – Relevant heights h_{inst} , h_0 and h_{rel} for calculation of A_{min} and m_{max}	117
Figure GG.4 – Airflow direction	118
Figure KK.1 – Front view of test apparatus labels	125
Figure KK.2 – Test apparatus with dimensions.....	126
Figure KK.3 – Top view of test apparatus.....	127
Table 101 – Power spectral density profile for vibration test.....	39
Table 102 – UV-C spectral irradiance measurement location	57
Table AA.1 – Examples for operating temperatures of the appliance	64
Table BB.1 – Selected information about refrigerants.....	65
Table DD.1 – Mandatory clauses in each of the instructions	70
Table GG.1 – Outline of Annex GG	85
Table GG.2 – Circulation airflow	90
Table GG.3 – Appliance with packaging.....	97
Table GG.4 – Appliance without packaging	97
Table GG.5 – Minimum air velocity	110

Table GG.6 – Refrigerant leak rate ($\dot{m}_{\text{leak}}$)	114

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES –
SAFETY –****Part 2-40: Particular requirements for electrical heat pumps,
air-conditioners and dehumidifiers**

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) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60335-2-40 has been prepared by subcommittee 61D: Appliances for air-conditioning for household and similar purposes, of IEC technical committee 61: Safety of household and similar electrical appliances. It is an International Standard.

This eighth edition cancels and replaces the seventh edition published in 2022. This edition constitutes a technical revision.

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

- a) Clause 12 : Part 1, Clause 12 has been made applicable;
- b) Clause 19: requirement added for **double wall heat exchangers** to be resistant against freezing;

- c) Clause 20: requirement modified for when to apply test probe 18;
- d) Clause 21: requirement added for **double wall heat exchangers** to resistant against the pressure of the refrigerant if one of the walls fails;
- e) Clause 22: requirement modified to reflect that appliances can operate continuously and can be operated remotely without giving rise to a hazard, and requirement added for **double wall heat exchangers** to be constructed to avoid refrigerant leaking into the secondary circuit;
- f) Annex LL has been deleted and replaced by a reference to IEC TS 63542:2024.

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

Draft	Report on voting
61D/538/FDIS	61D/542/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.

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/publications.

A list of all parts of the IEC 60335 series, under the general title: *Household and similar electrical appliances – Safety*, can be found on the IEC website.

This part 2 is to be used in conjunction with the latest edition of IEC 60335-1 and its amendments unless that edition precludes it; in that case, the latest edition that does not preclude it is used. It was established on the basis of the sixth edition (2020) of that standard.

NOTE 1 When "Part 1" is mentioned in this standard, it refers to IEC 60335-1.

This part 2-40 supplements or modifies the corresponding clauses in IEC 60335-1, so as to convert that publication into the IEC standard: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers.

When a particular subclause of Part 1 is not mentioned in this part 2, that subclause applies as far as is reasonable. When this standard states "addition", "modification" or "replacement", the relevant text in Part 1 is to be adapted accordingly.

NOTE 2 The following numbering system is used:

- subclauses, tables and figures that are numbered starting from 101 are additional to those in Part 1;
- unless notes are in a new subclause or involve notes in Part 1, they are numbered starting from 101, including those in a replaced clause or subclause;
- additional annexes are lettered AA, BB, etc.

NOTE 3 The following print types are used:

- requirements: in roman type;
- *test specifications: in italic type;*
- notes: in small roman type.

Words in **bold** in the text are defined in Clause 3. When a definition concerns an adjective, the adjective and associated noun are also in bold.

The following differences of a less permanent nature exist in the countries indicated below:

- 6.1: Class 0I appliances are allowed (Japan).
- 11.8: The temperature of the wooden walls in the test casing is limited to 85 °C (Sweden).

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, or
- revised.

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.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

INTRODUCTION

It has been assumed in the drafting of this International Standard that the execution of its provisions is entrusted to appropriately qualified and experienced persons.

Guidance documents concerning the application of the safety requirements for appliances can be accessed via TC 61 supporting documents on the IEC website

<https://www.iec.ch/tc61/supportingdocuments>

This information is given for the convenience of users of this International Standard and does not constitute a replacement for the normative text in this standard.

This standard recognizes the internationally accepted level of protection against hazards such as electrical, mechanical, thermal, fire and radiation of appliances when operated as in normal use taking into account the instructions. It also covers abnormal situations that can be expected in practice.

This standard takes into account the requirements of IEC 60364 as far as possible so that there is compatibility with the wiring rules when the appliance is connected to the supply mains. However, national wiring rules can differ.

If an appliance within the scope of this standard also incorporates functions that are covered by another part 2 of IEC 60335, the relevant part 2 is applied to each function separately, as far as is reasonable. If applicable, the influence of one function on the other is taken into account.

When a part 2 standard does not include additional requirements to cover hazards dealt with in Part 1, Part 1 applies.

NOTE 1 This means that the technical committees responsible for the part 2 standards have determined that it is not necessary to specify particular requirements for the appliance in question over and above the general requirements.

This standard is a product family standard dealing with the safety of appliances and takes precedence over horizontal and generic standards covering the same subject.

NOTE 2 Horizontal publications, basic safety publications and group safety publications covering a hazard are not applicable since they have been taken into consideration when developing the general and particular requirements for the IEC 60335 series of standards.

An appliance that complies with the text of this standard will not necessarily be considered to comply with the safety principles of the standard if, when examined and tested, it is found to have other features that impair the level of safety covered by these requirements.

An appliance employing materials or having forms of construction differing from those detailed in the requirements of this standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, may be considered to comply with the standard.

NOTE 3 Standards dealing with non-safety aspects of household appliances are:

- IEC standards published by TC 59 concerning methods of measuring performance;
- CISPR 11, CISPR 14-1 and relevant IEC 61000-3 series standards concerning electromagnetic emissions;
- CISPR 14-2 concerning electromagnetic immunity;
- IEC standards published by TC 111 concerning environmental matters.

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers

1 Scope

This clause of Part 1 is replaced by the following.

This part of IEC 60335 deals with the safety of electric **heat pumps, sanitary hot water heat pumps and air-conditioners**, incorporating motor-compressors as well as **hydronic fan coils units, dehumidifiers** (with or without motor-compressors), **thermoelectric heat pumps and partial units**, their maximum **rated voltage** being not more than 300 V for single phase appliances and 600 V for other appliances including direct current (DC) supplied appliances and **battery-operated appliances**.

Appliances not intended for normal household use but which nevertheless can be a source of danger to the public, such as appliances intended to be used by laypersons in shops, in light industry and on farms, are within the scope of this standard.

The appliances referenced above can consist of one or more factory-made assemblies. If provided in more than one assembly, the separate assemblies are used together, and the requirements are based on the use of matched assemblies.

NOTE 101 A definition of 'motor-compressor' is given in IEC 60335-2-34, which includes the statement that the term motor-compressor is used to designate either a hermetic motor-compressor or semi-hermetic motor-compressor.

NOTE 102 Requirements for containers intended for storage of the heated water included in **sanitary hot water heat pumps** are, in addition, covered by IEC 60335-2-21.

This standard does not take into account refrigerants other than group A1, A2L, A2 and A3 as defined by ISO 817. **Flammable refrigerants** are limited to those of a molar mass of more than or equal to 42 kg/kmol based on WCF (worst case formulation) as specified in ISO 817.

As far as practical, this standard deals with common hazards presented by appliances that are encountered in normal use and assumes that installation, servicing, decommissioning, and disposal are safely handled by competent persons and accidental release of refrigerants is avoided. However, it does not specify the criteria to ensure competence of persons during installation, servicing and disposal. Safety requirements during disposal are not specified in this standard.

NOTE 103 Annex HH provides informative requirements on competence of personnel. Criteria for competence of personnel for the purpose of certification schemes can be found in ISO 22712.

Unless specifications are covered by this standard, including the annexes, requirements for refrigerating safety are covered by:

- ISO 5149-1:2014, ISO 5149-1:2014/AMD1:2015, and ISO 5149-1:2014/AMD2:2021,
- ISO 5149-2:2014 and ISO 5149-2:2014/AMD1:2020,
- ISO 5149-3:2014 and ISO 5149-3:2014/AMD1:2021.

Supplementary heaters, or a provision for their separate installation, are within the scope of this standard, but only heaters which are designed as a part of the appliance package, the controls being incorporated in the appliance.

NOTE 104 Attention is drawn to the fact that

- for appliances intended to be used in vehicles or on-board ships or aircraft, additional requirements can be necessary;
- in many countries, additional requirements are specified, for example, by the national health authorities responsible for the protection of labour and the national authorities responsible for storage, transportation, building constructions and installations.

This standard does not apply to

- humidifiers intended for use with heating and cooling equipment (IEC 60335-2-88);
- appliances designed exclusively for industrial processing;
- appliances intended to be used in locations where special conditions prevail, such as the presence of a corrosive or explosive atmosphere (dust, vapour or gas).

2 Normative references

This clause of Part 1 is applicable except as follows.

Addition:

IEC 60068-2-52, *Environmental testing – Part 2: Tests – Test Kb: Salt mist, cyclic (sodium, chloride solution)*

IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements*

IEC 60079-7:2015, *Explosive atmospheres – Part 7: Equipment protection by increased safety "e"*
IEC 60079-7:2015/AMD1:2017

IEC 60079-14, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*

IEC 60079-15:2017, *Explosive atmospheres – Part 15: Equipment protection by type of protection "n"*

IEC 60335-2-34:2021, *Household and similar electrical appliances – Safety – Part 2-34: Particular requirements for motor-compressors*

IEC 60335-2-51, *Household and similar electrical appliances – Safety – Part 2-51: Particular requirements for stationary circulation pumps for heating and service water installations*

IEC 60695-1-10, *Fire hazard testing – Part 1-10: Guidance for assessing the fire hazard of electrotechnical products – General guidelines*

IEC 60695-10-2:2014, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test method*

IEC 60730-2-6, *Automatic electrical controls – Part 2-6: Particular requirements for automatic electrical pressure sensing controls including mechanical requirements*

IEC 62471:2006, *Photobiological safety of lamps and lamp systems*

IEC TS 63542:2024, *Refrigerant detection systems for flammable refrigerants*

ISO 527-3, *Plastics – Determination of tensile properties – Part 3: Test conditions for films and sheets*

ISO 817, *Refrigerants – Designation and safety classification*

ISO 1302¹, *Geometrical Product Specifications (GPS) – Indication of surface texture in technical product documentation*

ISO 2578, *Plastics – Determination of time-temperature limits after prolonged exposure to heat*

ISO 5149-1:2014, *Refrigerating systems and heat pumps – Safety and environmental requirements – Part 1: Definitions, classification and selection criteria*
ISO 5149-1:2014/AMD1:2015
ISO 5149-1:2014/AMD2:2021

ISO 5149-2:2014, *Refrigerating systems and heat pumps – Safety and environmental requirements – Part 2: Design, construction, testing, marking and documentation*
ISO 5149-2:2014/AMD1:2020

ISO 5149-3:2014, *Refrigerating systems and heat pumps – Safety and environmental requirements – Part 3: Installation site*
ISO 5149-3:2014/AMD1:2021

ISO 5151, *Non-ducted air conditioners and heat pumps – Testing and rating for performance*

ISO 7010:2019, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

ISO 13253, *Ducted air-conditioners and air-to-air heat pumps – Testing and rating for performance*

ISO 13256 (all parts), *Water-source heat pumps – Testing and rating for performance*

ISO 13355, *Packaging – Complete, filled transport packages and unit loads – Vertical random vibration test*

ISO 14903, *Refrigerating systems and heat pumps – Qualification of tightness of components and joints*

ISO 15042, *Multiple split-system air-conditioners and air-to-air heat pumps – Testing and rating for performance*

3 Terms and definitions

This clause of Part 1 is applicable except as follows.

3.1.4 Addition:

Note 101 to entry: If the appliance comprises electrical accessories, including fans, the **rated power input** is based upon the total maximum **electrical power input** with all accessories energized, when operating continuously under the appropriate environmental conditions. If the **heat pump** can be operated in the heating or cooling mode, the **rated power input** is based upon the input in the heating or in the cooling mode, whichever is the greater.

3.5.4 Addition:

Note 101 to entry: Appliances connected to water pipes or refrigerant pipes that are secured to the building are also **fixed appliances**.

¹ Withdrawn.

3.8.101

particle foam material

closed cell material moulded from thermoplastic particles (e.g. beads) with expanding agent

3.101

heat pump

appliance which takes up heat at a certain temperature and releases heat at a higher temperature

Note 1 to entry: When operated to provide heat (e.g., for space heating or water heating), the appliance is said to operate in the heating mode; when operated to remove heat (for example, for space cooling), it is said to operate in the cooling mode.

Note 2 to entry: A **heat pump** can contain a combination of **condensing unit** or **condenser unit** and an **evaporating unit** or **evaporator unit** and can be equipped to operate in a reverse cycle mode.

3.102

sanitary hot water heat pump

heat pump intended to transfer heat to water suitable for human consumption

3.103

air-conditioner

encased assembly or assemblies designed as an appliance to provide delivery of conditioned air to an enclosed space, room or zone

Note 1 to entry: It includes an electrically operated **refrigerating system** for cooling and possibly dehumidifying the air.

Note 2 to entry: It can have means for heating, circulating, cleaning and humidifying the air.

Note 3 to entry: An **air-conditioner** can contain a combination of **condensing unit** or **condenser unit** and an **evaporating unit** or **evaporator unit**.

3.104

dehumidifier

encased assembly designed to remove moisture from its surrounding atmosphere

Note 1 to entry: It includes an electrically operated **refrigerating system** and the means to circulate air. It also includes a drain arrangement for collecting and storing and/or disposing of the condensate.

3.108

wet-bulb temperature

WB

temperature indicated when the temperature-sensitive element in a wetted wick has reached a state of constant temperature (evaporative equilibrium)

3.109

dry-bulb temperature

DB

temperature indicated by a dry, temperature-sensitive element shielded from the effects of radiation

3.110

evaporator

heat exchanger in which refrigerant liquid is vaporized by absorption of heat

3.111

heat exchanger

device specifically designed to transfer heat between two physically separated fluids (gas or liquid)

3.112**indoor heat exchanger**

heat exchanger designed to transfer heat to the indoor parts of the building or to the indoor hot water supplies (e.g. sanitary water) or to remove heat therefrom

3.113**outdoor heat exchanger**

heat exchanger designed to remove or release heat from the heat source (for example, ground water, outdoor air, exhaust air, water or brine)

3.114 Supplementary heaters**3.114.1****supplementary heater**

electric heater that supplements or replaces the output of the refrigerant circuit for the purpose of heating air or water

3.114.2**supplementary water heater**

supplementary heater specifically for the purpose of heating water

3.114.3**supplementary air heater**

supplementary heater specifically for the purpose of heating air in conjunction with, or instead of, the refrigerating circuit

Note 1 to entry: **Supplementary air heaters** include electric heaters provided as part of an appliance with cooling-only refrigerant circuits.

3.115**pressure-limiting device**

mechanism that automatically responds to a predetermined pressure by stopping the operation of the pressure-imposing element

3.116**pressure-relief device**

pressure actuated valve or rupture member which functions to relieve excessive pressure automatically

3.117**appliances accessible to the general public**

appliances intended to be located in residential buildings or in commercial buildings in a location without restricted access

3.118**appliances not accessible to the general public**

appliances which are located in a secured location with restricted access (e.g. machine rooms, rooftop and the like, or at a level above 2,5 m)

3.119**hydronic fan coil unit**

factory-made assembly which provides the function of forced circulation of air for heating and/or cooling, which can also include the function of **dehumidification** and/or filtering of air, but which does not include the source of cooling or heating

Note 1 to entry: **Hydronic fan coil units** can include provision for electric resistance heating. **Heat exchanger** coils are intended for hydronic heating and cooling only.

3.120

flammable refrigerant

refrigerant classified as safety group A2L, A2 or A3 according to ISO 817

3.121

refrigerating system

combination of interconnected refrigerant containing parts constituting one closed refrigerant circuit in which the refrigerant is circulated for the purpose of extracting heat at the low temperature side to reject heat at the high temperature side by changing the state of the refrigerant

3.122

maximum allowable pressure

maximum pressure for which the equipment is designed, as specified by the manufacturer

Note 1 to entry: **Maximum allowable pressure** constitutes a limit to the operating pressure of a **refrigerating system**, hydronic circuit or sanitary hot water tank whether the equipment is working or not, see Clause 21.

3.123

low-pressure side

part(s) of a **refrigerating system** operating at the **evaporator** pressure

3.124

high-pressure side

part(s) of a **refrigerating system** operating at the **condenser** pressure

3.125

service port

means to access the refrigerant in a **refrigerating system** for the purpose of charging or servicing the system, typically a valve, tube extension or entry location

3.126

factory sealed single package unit

factory assembly of components of **refrigerating system** fixed on a common mounting to form a discrete unit in which all **refrigerating system** parts have been sealed tight by welding, brazing or a similar permanent connection during the manufacturing process

3.127

pre-charged pipe sets

interconnecting refrigerant lines which are supplied with the unit and supplied with a **refrigerant charge** for the purpose of completing the **refrigerating system** in the field for appliances that are made up of more than one subassembly and are assembled in the field to complete the **refrigerating system**

3.128

condenser

heat exchanger in which refrigerant vapour is condensed by removal of heat

3.129

condensing unit

factory-made assembly that includes one or more motor-compressors, **condenser** in cooling mode and motor-driven fan, blower or pump to circulate the heat transfer fluid through the **condenser** with associated operational controls in addition to the necessary wiring

Note 1 to entry: These units are intended for field connection to an **evaporator unit**. A **condensing unit** can also be equipped to operate in the reverse cycle mode. A **condensing unit** can include expansion device(s).

3.130**condenser unit**

factory-made assembly that includes one or more **condensers** in cooling mode and motor-driven fan, blower or pump to circulate the heat transfer fluid through the **condenser** with associated operational controls in addition to the necessary wiring

Note 1 to entry: These units are intended for field connection to an **evaporating unit**. A **condenser unit** can also be equipped to operate in the reverse cycle mode.

Note 2 to entry: A **condenser unit** does not include a motor-compressor or expansion device.

3.131**evaporating unit**

factory-made assembly that includes one or more motor-compressors, **evaporator** in cooling mode, expansion device(s), and motor-driven fan, blower or pump to circulate fluid through the **evaporator** with associated operational controls in addition to the necessary wiring

Note 1 to entry: These units are intended for field connection to a **condenser unit**. An **evaporating unit** can also be equipped to operate in the reverse cycle mode and can include provision for electric resistance heating or similar sources of auxiliary heat.

3.132**evaporator unit**

factory-made assembly that includes one or more **evaporators** in cooling mode, and can include a motor-driven fan, blower or pump to circulate fluid through the **evaporator** with associated operational controls in addition to the necessary wiring

Note 1 to entry: These units are intended for field connection to a **condensing unit**. An **evaporator unit** can also be equipped to operate in the reverse cycle mode and can include provision for electric resistance heating or similar sources of auxiliary heat. An **evaporator unit** can include expansion device(s).

Note 2 to entry: An **evaporator unit** does not include a motor-compressor.

3.133**partial unit**

condensing unit, **evaporating unit**, **condenser unit**, or **evaporator unit** which are part of a total assembly of a **heat pump**, **air-conditioner**, or **sanitary hot water heat pumps** where not all assemblies to create the complete **refrigerating system** are specified by the manufacturer

Note 1 to entry: **Partial units** are evaluated for safety as stand-alone.

3.134**installed height** h_{inst}

height of the bottom of the appliance relative to the floor of the room after installation

Note 1 to entry: The **installed height** is given in metres.

3.135**release offset** h_{rel}

distance from the bottom of the appliance to an opening where the refrigerant can leave the appliance in the event of a refrigerant leak

Note 1 to entry: The **release offset** is given in metres.

3.136**refrigerant charge** m_c

actual **refrigerant charge** of a single **refrigerating system**

Note 1 to entry: The **refrigerant charge** is expressed in kg.

3.137

maximum refrigerant charge

$m_{\max}$

maximum refrigerant charge for a single **refrigerating system** as result from a calculation for room area or similar

Note 1 to entry: The **maximum refrigerant charge** is expressed in kg.

3.138

refrigerant detection system

sensing system which gives an output signal in response to a pre-set concentration of refrigerant in the environment

Note 1 to entry: A **refrigerant detection system** can have multiple **refrigerant sensors**.

3.139

auto ignition temperature

AIT

lowest temperature at or above which a chemical can spontaneously ignite in a normal atmosphere, without an external source of ignition, such as a flame or spark

[SOURCE: ISO 5149-1:2014, 3.7.7, modified – the abbreviated term "AIT" has been added and "of a substance" has been deleted".]

3.140

hot surface ignition temperature

highest temperature at which a refrigerant does not ignite when tested in accordance with Annex KK

3.141

A2L refrigerant

refrigerant classified as safety group A2L according to ISO 817

3.142

lower flammability limit

LFL

minimum concentration of the refrigerant that is capable of propagating a flame through a homogeneous mixture of the refrigerant and air

Note 1 to entry: Data is listed in Annex BB.

[SOURCE: ISO 817:2014, 3.1.24, modified – "under the specified test conditions at 23,0 °C and 101,3 kPa" and Notes to entry deleted.]

3.143

enhanced tightness refrigerating system

refrigerating system in which the indoor units are designed and fabricated to ensure a high level of confidence that large refrigerant leak rates will not occur in **normal operation** and abnormal operation

3.144

refrigerant distribution assembly

separate refrigerant assembly which is installed in the interconnecting refrigerant lines for the purpose of distributing refrigerant flow to one or more indoor units

3.145**Void****3.146****circulation airflow**

mechanically induced airflow movement within the space or duct-connected spaces

3.147**Void****3.148****Void****3.149****Void****3.150****UV-C lamp**

source made to produce ultraviolet radiation in the range of 100 nm to 280 nm wavelengths

Note 1 to entry: There are several types of such lamps used for photobiological, photochemical and biomedical purposes.

3.151**Void****3.152****UV-C germicidal lamp system**auxiliary device which utilizes **UV-C lamps** that directly generate germicidal radiation

Note 1 to entry: **UV-C germicidal lamp systems** are typically used to supplement the normal unit air filters for enhanced air purification and surface cleaning of the evaporator coil and surrounding area.

3.153**UV-C spectral irradiance**

measured electromagnetic radiation power density at a particular wavelength of 254 nm at a specified distance

Note 1 to entry: The spectral irradiance E_{254} is measured in $\mu\text{W}/\text{cm}^2$.

3.154**UV-C barrier**

additional guard or shield that prevents UV-C light from exiting the unit or damaging internal non-metallic materials

3.155**transcritical refrigerating system****refrigerating system** where evaporation occurs below the critical point and heat rejection can occur above the critical point of the refrigerant (e.g. R744)**3.156****releasable charge** m_{rl} mass of refrigerant that can be released into the indoor space from a **refrigerating system** in the event of a leak

Note 1 to entry: Any part of the **refrigerant charge** that leaks to the outdoor is excluded from the **releasable charge**.

3.157**operating state**function that the appliance is in at a specific time during **normal operation**

Note 1 to entry: Examples include standby, cooling mode, heating mode and defrosting.

3.158

releasable charge limited system

refrigerating system in which the **releasable charge** is limited by design measures

EXAMPLE 1 Systems relying on closing **safety shut-off valves** when the compressor is off are examples of **releasable charge limited systems** not relying on **leak detection systems**.

EXAMPLE 2 Systems relying on measuring temperature, pressure, ultrasonic leak detection, or other working parameters to detect a leak are examples of **releasable charge limited systems** not relying on **refrigerant detection systems**.

3.159

safety shut-off valve

valve for the purpose of limiting the amount of **releasable charge**

3.160

leak detection system

sensing system which responds to refrigerant leaking from a **refrigerating system**

EXAMPLE A **refrigerant detection system** is an example of a **leak detection system**.

Note 1 to entry: A **leak detection system** can include gas sensing, ultrasonic or other such methods demonstrated to be sufficiently effective.

3.161

potential leak point

any point in the **refrigerating system** that can be a weak point due to manufacturing processes, exposure to damage, sharpness of a bend, or similar stresses

EXAMPLE **Potential leak points** can include parts under stress or vibration.

3.162

pressure vessel

any refrigerant-containing part of a refrigerating system other than

- compressors,
- pumps,
- component parts of sealed absorption systems,
- evaporators, each separate section of which does not exceed 15 l of refrigerant-containing volume,
- coils,
- piping and its valves, joints, and fittings,
- control devices, and
- pressure-containing components (including headers) having an internal diameter or largest cross-sectional dimension not greater than 152 mm

[SOURCE: ISO 5149-1:2014, 3.4.7]

3.163

refrigerant sensor

assembly in which the sensing element is housed and that can also contain associated circuit components

[SOURCE: IEC 60079-29-1:2016, 3.3.2, modified – "sensor" replaced by "refrigerant sensor".]

3.164

limited life refrigerant sensor

refrigerant sensor which is expected to fail within the life of the appliance

3.165**thermoelectric heat pump**

solid-state **heat pump**, activated by an electric current, which takes up heat at a certain temperature and releases heat at a higher temperature

Note 1 to entry: A Peltier element is an example of such technology.

3.166**double wall heat exchanger**

heat exchanger with two walls between the refrigerant and a secondary fluid

Note 1 to entry: **Double wall heat exchangers** avoid ingress of refrigerant into the secondary circuit or secondary fluid into the refrigeration circuit in case of leakage in one separating wall.

4 General requirement

This clause of Part 1 is applicable.

5 General conditions for the tests

This clause of Part 1 is applicable except as follows.

5.2 Addition:

*The testing of Clause 21 may be carried out on separate samples. The testing of Clause 11, Clause 19 and Clause 21 shall require that pressure measurements be made at various points in the **refrigerating system**.*

NOTE 101 For reference purposes, the temperatures on the refrigerant piping can be measured during the test of Clause 11.

*If the tests of Annex FF (leak simulation tests) and Annex QQ (methods for determining **releasable charge**) are carried out, at least one additional specially prepared sample is required.*

If the test of Annex NN has to be carried out, an additional appliance may be used.

Tests of Clause 15 may be conducted on a separate sample. The test of 19.104.2 through 19.104.8 may be run in any sequence within Clause 19.

5.6 Addition:

Any controls which regulate the temperature or humidity of the conditioned space are rendered inoperative during the test.

5.7 Addition:

The tests and test conditions of Clause 10 and Clause 11 are carried out under the most severe operating conditions within the operating temperature range specified by the manufacturer. Annex AA provides examples of such temperature conditions.

5.10 Addition:

For split units, the refrigerant lines shall be installed in accordance with the installation instructions. The length of the pipe shall be between 5 m and 7,5 m. Where the installation instructions specify a maximum pipe length of less than 5 m, the length of pipe shall be the maximum length specified in the installation instructions, and where the installation instructions specify a minimum pipe length of more than 7,5 m, the length of pipe shall be the minimum length specified in the installation instructions. The thermal insulation of the refrigerant lines shall be applied in accordance with the installation instructions.

6 Classification

This clause of Part 1 is applicable except as follows.

6.1 Modification:

Appliance shall be of **class I**, **class II** or **class III**.

6.2 Addition:

Appliances shall be classified according to degree of protection against harmful ingress of water in accordance with IEC 60529:

- appliances or parts of appliances intended for outdoor use shall be at least IPX4;
- appliances intended only for indoor use (excluding laundry rooms) may be IPX0;
- appliances intended to be used in laundry rooms shall be at least IPX1.

6.101 Appliances shall be classified according to the accessibility either as **appliance accessible to the general public** or as **appliance not accessible to the general public**.

Compliance is checked by inspection.

7 Marking and instructions

This clause of Part 1 is applicable except as follows.

7.1 Modification:

Replace the second dash by:

- symbol for nature of supply including number of phases, unless for single phase operation;

Addition:

- **rated frequency**;
- **refrigerant charge** for each **refrigerating system**;
- refrigerant designation in accordance with ISO 817;
- **maximum allowable pressure** for the storage tank (for **sanitary hot water heat pumps**);
- **maximum allowable pressure** in the water and/or brine circuit for the **heat exchanger** for **hydronic fan coil units**;
- **maximum allowable pressure** for the refrigerant circuit; if the **maximum allowable pressures** for the suction and discharge side differ, a separate marking is required;

- for **pre-charged pipe sets**
 - refrigerant designation in accordance with ISO 817;
 - the **refrigerant charge** in the line set;
 - **maximum allowable pressure**;
 - if charged with a flammable refrigerant, the flame symbol ISO 7010-W021 (2011-05) including the safety group per ISO 817;
- ratings in watts and voltage of a **UV-C germicidal lamp system** if employed.

Appliances shall be marked with all of the designations and the rated inputs of the **supplementary heaters** for which they are intended to be used and shall have provision for identifying the actual heater that is field installed.

Unless it is evident from the design, the enclosure of the appliance shall be marked, by words or by symbols, with the direction of the fluid flow.

If a **flammable refrigerant** is used, a warning symbol (flame symbol: ISO 7010-W021 (2011-05)) including the safety group per ISO 817 as described in 7.6 shall be placed within sight of the marking of the refrigerant designation on the appliance. The height of the symbol shall be at least 10 mm, and it is not necessary for the symbol to be in colour.

NOTE 101 The refrigerant designation is typically found on the name plate of the appliance.

Appliances using **flammable refrigerants** shall be marked with the flame symbol ISO 7010-W021 (2011-05) including the safety group per ISO 817. The height of the triangle used for the symbol shall be at least 30 mm. The required markings shall be provided on all units which contain compressors.

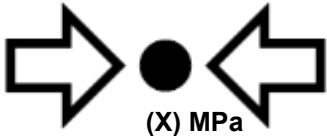
If not already visible when accessing a **service port** and if a **service port** is provided, the **service port** shall be marked to identify the type of refrigerant. If the refrigerant is flammable, symbol ISO 7010-W021 (2011-05) including the safety group per ISO 817 shall be included, without specifying the colour.

If a **flammable refrigerant** is used, the symbols for "read operator's manual" (symbols ISO 7000-0790 (2004-01)) and "service indicator; read technical manual" (ISO 7000-1659 (2004-01)) shall be placed on the appliance in locations visible to the persons required to know the information. The height of the symbol shall be at least 10 mm.

Appliances which are not **fixed appliances**, using a **flammable refrigerant** with a **refrigerant charge** (m_c) of the appliance greater than m_1 according to GG.1.2, shall be marked with symbol ISO 7000-0434A (2004-01) immediately followed by the minimum room floor area symbol IEC 60417-6412 (2019-03), where "A" is the minimum room area in m^2 as determined according to Annex GG. The markings shall be placed on the outside of the appliance such that it is visible during normal operation.

Appliances employing **refrigerating systems** with **maximum allowable pressures** greater than 7 MPa shall be marked with symbol ISO 7000-1701 (2004-01) followed by the text "(X) MPa" and the "read operator's manual", ISO 7000-0790 (2004-01), where: "X" is the **maximum allowable pressure**.

7.6 Addition:

	[symbol ISO 7000-1659 (2004-01)]	service indicator; read technical manual
 safety group per ISO 817	[symbol ISO 7010-W021 (2011-05) plus the safety group per ISO 817 not less than 1/3 of the height of the symbol adjacent to the symbol]	warning; flammable material
	[symbol ISO 7000-1701 (2004-01)]	pressure
	[symbol IEC 60417-6040 (2010-08)]	ultraviolet radiation, instructional safeguard
	[symbol IEC 60417-6412 (2019-03)]	minimum room floor area

7.12.1 Addition:

In particular, the following information shall be supplied:

- that national wiring regulations can impose additional requirements;
- the dimensions of the space necessary for correct installation of the appliance including the minimum permissible distances to adjacent structures;
- for appliances with **supplementary air heaters**, the minimum clearance from the appliance to combustible surfaces;
- a wiring diagram with a clear indication of the connections and wiring to external control devices and **supply cord**;
- the range of external static pressures at which the appliance was tested (add-on **heat pumps** and ducted appliances with **supplementary air heaters** only);
- the method of connection of the appliance to the electrical supply and interconnection of separate components;
- indication of which parts of the appliance are suitable for outdoor use, if applicable;
- details of type and rating of fuses, or rating of circuit breakers;
- details of supplementary heating elements that may be used in conjunction with the appliance, including fitting instructions either with the appliance or with the **supplementary heater**;

- j) maximum and minimum water or brine operating temperatures;
- k) maximum and minimum water or brine operating pressures;
- l) maximum and minimum operating indoor and outdoor air temperatures;
- m) instructions on charging of refrigerants when addition of charge is required by the manufacturer for completing the **refrigerating system**;
- n) when the symbol IEC 60417-6412 (2019-03) is used, a warning that the appliance shall be installed, operated and stored in a room with a floor area not less than the minimum room area.

Open storage tanks of **heat pumps** for water heating shall be accompanied by an instruction sheet stating that the vent shall not be obstructed.

7.12.9 *Modification:*

Add 7.12.101 and 7.12.102 after the reference to 7.12.1 to 7.12.8.

7.12.101 For **appliances not accessible to the general public**, the classification according to 6.101 shall be included.

Compliance is checked by inspection.

7.12.102 For appliances using **flammable refrigerants**, installation instructions, service, maintenance and repair instructions, and decommissioning instructions, either as separate or combined instructions, shall be made available and include the information given in Annex DD.

Compliance is checked by inspection.

Additional guidance on transportation, marking and storage for units that employ **flammable refrigerants** is given in Annex CC.

7.15 *Addition:*

A marking may be located on a panel that can be removed for installation or service, providing that the panel shall be in place for the intended operation of the appliance.

7.101 A marking shall be provided for a replaceable fuse or a replaceable overload **protective device** provided as a part of a product or remote control assembly. It shall be visible when the cover or door of the compartment is open. This marking shall specify

- the rating of the fuse in amperes, the type and voltage rating, or
- the manufacturer and model designation of the replaceable overload **protective device**.

Compliance is checked by inspection.

7.102 If the appliance is intended for permanent connection to fixed wiring with aluminium wires, the marking shall so state.

Compliance is checked by inspection.

7.103 For appliances made up of more than one factory made assembly specified by the manufacturer to be used together, instructions shall be provided for completing the assembly to ensure compliance with the requirements.

Compliance is checked by inspection.

7.104 For **partial units**, the instructions or markings shall include the following additional information.

- For **evaporating units** and **condensing units**, the instructions or markings shall include wording to assure that the maximum operating pressure is considered when connecting to any **condenser unit** or **evaporator unit**.
- For **evaporating units**, **condensing units** and **condenser units**, the instructions or markings shall include refrigerant charging instructions.
- A warning to ensure that **partial units** shall only be connected to an appliance suitable for the same refrigerant.
- This unit <model xxx> is a **partial unit air-conditioner**, complying with **partial unit** requirements of IEC 60335-2-40, and must only be connected to other units that have been confirmed as complying to corresponding **partial unit** requirements of IEC 60335-2-40.
- The electrical interfaces shall be specified with purpose, voltage, current, and safety class of construction.
- The **SELV** connection points, if provided, are to be clearly indicated in the instructions. The connection point should be marked with the "read the instructions" symbol per ISO 7000-0790 (2004-01) and the Class III symbol according to IEC 60417-5180 (2003-02).

Compliance is checked by inspection.

7.105 For appliances using **flammable refrigerants** that have safety features depending upon the proper function of a **leak detection system**, the instructions or unit markings shall contain the substance of the following:

"This unit is equipped with a **leak detection system** for safety. For leak detection to be effective, the unit must be electrically powered at all times after installation, other than when servicing."

If any remote located **refrigerant sensor** is employed to detect leaked refrigerant, such remote located **refrigerant sensor** shall also apply this marking or be accompanied by such instructions.

Compliance is checked by inspection.

7.106 For appliances using **flammable refrigerants** that have safety features depending upon the proper function of electrically powered safety measures, the instructions or unit markings shall contain the substance of the following:

"This unit is equipped with electrically powered safety measures. For the safety measures to be effective, the unit must be electrically powered at all times after installation, other than when servicing."

If any mechanical ventilation unit is employed to dilute leaked refrigerant and is not integrated in the appliance, such unit shall also apply this marking or be accompanied by such instructions.

Compliance is checked by inspection.

7.107 For **flammable refrigerants**, when addition of charge is required by the installation instructions for completing the **refrigerating system**, the manufacturer shall provide a label that allows the installer to note the resulting total **refrigerant charge** for each **refrigerating system**. See Figure 101 for an example of a label for field charged units.

Compliance is checked by inspection.

7.108 For appliances using **flammable refrigerants**, excluding appliances with **A2L refrigerant charge** not exceeding m_1 , the flame symbol ISO 7010-W021 (2011-05) including the safety group per Annex BB described in 7.6 shall be visible on the packaging of the appliance if the appliance is charged with refrigerant.

The perpendicular height of the symbol shall be at least 30 mm.

Compliance is checked by inspection.

7.109 Appliances employing **UV-C germicidal lamp systems** shall be marked with ultraviolet radiation hazard symbol IEC 60417-6040 (2010-08) and the read operator's manual symbol ISO 7000-0790 (2004-01) in the following locations:

- doors and access panels that provide direct access to an area within the appliance where the measured **UV-C spectral irradiance** is greater than $1,7 \mu\text{W}/\text{cm}^2$;
- **user maintenance** access panels,
- **UV-C barriers**.

Compliance is checked by inspection.

7.110 For appliances that employ **UV-C germicidal lamp systems**, the instructions shall include the substance of the following:

- this appliance contains a **UV-C lamp**;
- read the maintenance instructions before opening the appliance;
- details for cleaning and other **user maintenance** of the appliance. They shall state that prior to cleaning or other maintenance, the appliance must be disconnected from the supply mains;
- the method, frequency of cleaning, and necessary precautions to be taken;
- precautions to be taken when replacing UV-C emitters and starters, if applicable;
- unintended use of the appliance or damage to the housing can result in the escape of dangerous UV-C radiation. UV-C radiation can, even in small doses, cause harm to the eyes and skin;
- appliances that are obviously damaged must not be operated;
- the appliance must be disconnected from the supply before replacing the **UV-C lamp**;
- doors and access panels bearing the ultraviolet radiation hazard symbol which can have **UV-C spectral irradiance** greater than $1,7 \mu\text{W}/\text{cm}^2$ are provided with an interlock switch to interrupt the power to the **UV-C lamps** for your safety. Do not over-ride;
- before opening doors and access panels bearing the ultraviolet radiation hazard symbol for conducting the **user maintenance**, it is recommended to disconnect the power;
- **UV-C barriers** bearing the ultraviolet radiation hazard symbol should not be removed;
- for appliances with **UV-C lamps**, information on the replacement of **UV-C lamps** shall be given, including the model and/or part number;
- if field installed, the factory specified **UV-C germicidal lamp systems** approved for use with the appliance shall be specified in the instructions by the specific model number;
- do not operate **UV-C lamps** outside of the appliance.

Compliance is checked by inspection.

7.111 Appliances employing **refrigerating systems** with **maximum allowable pressures** greater than 7 MPa shall be marked within sight of the refrigerant service ports with the following:

- the symbol ISO 7000-1701 (2004-01) including the text "(X) MPa", where; "X" is not less than the **maximum allowable pressure**.

Compliance is checked by inspection.

8 Protection against access to live parts

This clause of Part 1 is applicable except as follows.

8.1.1 Addition:

Test probe 18 of IEC 61032 is not applied to parts of appliances that according to the installation instructions are required to be mounted at a height exceeding 1,8 m above the floor.

8.1.5 Addition:

For appliances which have a dedicated installation panel or cover and which cannot be installed without them, compliance is checked according to 5.10 (after installation according to the installation instructions).

9 Starting of motor-operated appliances

This clause of Part 1 is not applicable.

10 Power input and current

This clause of Part 1 is applicable.

11 Heating

This clause of Part 1 is applicable except as follows.

11.1 Addition:

If the temperature of the motor winding exceeds the value specified in Table 3 or if there is doubt with regard to the classification of the insulation system employed in a motor, compliance is checked by the tests of Annex C.

11.2 Replacement:

11.2.1 *Appliances are installed in one or more test rooms in accordance with the installation instructions. In particular,*

- *clearances to adjacent surfaces specified by the manufacturer shall be maintained;*
- *adjustable limit controls are set at the maximum cut-out setting and the minimum differential permitted by the control adjusting means.*

*For appliances provided with **supplementary air heaters**, an additional test casing as described in 11.2.5 is used.*

11.2.2 For heating tests of ducted appliances with **supplementary air heaters**, an inlet duct is connected to the inlet air opening of the appliance (assuming that the appliance is intended to be so applied). The duct shall be the same size as the flanges, if flanges are provided. If flanges are not provided, the duct shall be the same size as the inlet opening.

An appliance that includes or has provision for **supplementary air heater** is fitted with an outlet duct in accordance with Figure 102a) or Figure 102b), depending on the direction of the airflow.

The inlet duct is provided with an adjustable restricting means by which the airflow can be reduced.

The restriction should be uniform across the duct's cross-sectional area, so that the full heating coil surface will be exposed to the airflow except when the restriction is closed.

For non-ducted appliances, other means may be used to uniformly restrict the inlet.

The distance from the air outlet opening of the appliance to the furthest point on the test duct, perpendicular to the outlet opening, shall be no more than the value of:

- for upflow appliances, $(AB)^{0,5}$ as shown in Figure 102a) or the minimum distance specified by the manufacturer, whichever is lower;
- for downflow appliances, $300 + (AB)^{0,5}$ as shown in Figure 102b) or the minimum distance specified by the manufacturer, whichever is lower.

NOTE 101 For horizontal ducted products, reference is made to Figure 102b), rotated 90° counter clockwise.

NOTE 102 Appliances can be specified by the manufacturer for use in applications with limited space for the appliance and connected ducts.

EXAMPLE 101 For upflow appliances intended for use in manufactured (mobile) homes, the combined height of the appliance and ducts is typically limited to 2,1 m (7 ft) minus the specified clearance to combustible material.

EXAMPLE 102 For downflow appliances intended for use in manufactured (mobile) homes, the distance from the air outlet opening to the furthest point on the test duct, perpendicular to the outlet opening, is typically reduced to not less than $25,4 + (AB)^{0,5}$.

11.2.3 A ducted appliance which does not include **supplementary air heaters**, is fitted with an outlet duct sized to fit the casing flanges, or opening without flanges, or locations marked for flanges, and arranged to discharge away from the return air inlet.

The hot air outlet duct is provided with a restricting means to obtain the maximum static pressure given in the instructions.

11.2.4 For the evaluation and testing of **partial units**, the following test set-up and conditions are to be applied:

- **evaporator units** and **condenser units** are tested as individual units at the maximum ambient temperature stated in the instructions. If not stated in the instructions, these units shall be tested at an ambient temperature that is equal to the saturated dew point temperature of the refrigerant at the marked **maximum allowable pressure** ($\pm 0,1$ MPa) minus 10 K (± 1 K);
- **condensing units** are tested in the cooling mode only, at the maximum specified ambient temperature with 9 K (± 1 K) sub-cooling and the maximum specified evaporating pressure with 11 K (± 1 K) superheat. For **condensing units** provided with expansion device(s), the superheat/sub-cooling is to be as under the normal control of the expansion device(s);
- **evaporating units**, intended for cooling only, are tested in the cooling mode only with a condensing pressure that is equal to the marked **maximum allowable pressure** ($\pm 0,1$ MPa) with 9 K (± 1 K) sub-cooling;
- **evaporating units** that are intended for reverse cycle operation are tested in the heating mode only, at the maximum specified evaporating pressure.

NOTE 101 Testing for **condensing units** and **evaporating units** requires connection to calorimeter stand or similar device capable of controlling the refrigerant entering and leaving conditions as specified in the test above. **Condenser units** and **evaporator units** do not require a calorimeter stand or similar device.

11.2.5 *The test casing consists of plywood walls having a thickness of about 20 mm, with dull black painted inside surfaces and all joints sealed. The distances between the casing and the surfaces of the appliance and the outlet duct, if any, are equal to the minimum clearances according to the instructions.*

For appliances not specified for installation with minimum clearances, as an alternative to the plywood test casing in direct contact with the appliance, glass fibre insulating material having a thickness of at least 25 mm and a density of at least 16 kg/m³ shall be wrapped closely around the appliance and the outlet duct, and thermocouples shall be placed in direct contact with the enclosure.

11.3 *Modification:*

Replace the 1st paragraph by:

Temperatures other than those of windings are determined by means of thermocouples which are sized and so chosen and positioned that they have the minimum effect on the temperature of the part under test.

NOTE 101 Thermocouples having wires with a diameter not exceeding 0,3 mm are generally considered to have minimum effect on temperature when measuring small parts such as electronic components.

Addition:

The temperatures in the duct are to be measured by means of a thermocouple grid consisting of nine thermocouples of identical length, wired in parallel to form a grid with a thermocouple located centrally in each of nine equal duct areas in a plane perpendicular to the axis of the airflow. For non-ducted appliances, the thermocouple grid shall be located within 25 mm of the outlet air opening and perpendicular to the opening. The temperature of the air measured by the thermocouple grid shall not exceed 92 °C.

11.4 *Replacement:*

*Appliances are operated under **normal operation** at a supply voltage between 0,94 times the lowest **rated voltage** and 1,06 times the highest **rated voltage**, the voltage chosen being that which gives the most unfavourable result.*

11.5 *This subclause of Part 1 is not applicable.*

11.6 *This subclause of Part 1 is not applicable.*

11.7 *Addition:*

Where an appliance can be operated in the cooling mode as well as the heating mode, a test is conducted in each mode.

Appliances with defrost facilities are additionally submitted for a defrost test in the most unfavourable conditions.

All appliances are operated continuously until steady conditions are achieved, except for defrost tests.

*Appliances are operated under **normal operation** with flow rates which give the most unfavourable result.*

NOTE 101 Consideration can be given to air or liquid flow rates, air or liquid temperatures, (air) static pressure, compressor operation conditions, etc.

11.8 Addition:

Temperatures shall not exceed the temperature limit according to the following formula:

$$\text{Temperature limit [}^{\circ}\text{C]} = 25\text{ }^{\circ}\text{C} + \text{Table 3 value} \quad (101)$$

NOTE 101 Formula (101) calculates the temperature limit from the temperature rise as defined in Table 3.

Table 3 – Maximum normal temperature rises

Modification:

In the first row, change "Windings" to "Windings other than windings of sealed motor-compressors".

Addition:

Parts	Temperature rise K
Windings of sealed motor-compressors ^{aa}	
– with synthetic insulation	115
– with non-synthetic insulation	105
Duct and discharge plenum at points of specified zero clearance to test enclosure	67
^{aa} Not required for motor-compressors that comply with IEC 60335-2-34:2021 (including its Annex AA).	
NOTE 2 Addition:	
Heat pumps, air-conditioners and other appliances covered by this standard can have other ambient temperature than normal household appliances, for example some products are used outdoors	

12 Charging of metal-ion batteries

This clause of Part 1 is applicable.

13 Leakage current and electric strength at operating temperature

This clause of Part 1 is applicable except as follows.

13.2 Modification:

For stationary class I motor-operated appliances, the leakage current shall not exceed 3,5 mA, or 2 mA per kilowatt rated power input, whichever is higher. The maximum value shall not exceed 10 mA for appliances accessible to the general public and 30 mA for appliances not accessible to the general public.

14 Transient overvoltages

This clause of Part 1 is applicable.

15 Moisture resistance

This clause of Part 1 is replaced by the following.

15.1 Electrical components of appliances shall be protected against the ingress of water which can be present in the appliance as a result of rain, overflow from the drain pan, or defrosting.

Compliance is checked by the tests of 15.2, followed immediately by the overflow test of 15.3; and this is followed by the defrost test of 11.7, and the tests of Clause 16.

*Following these tests, an inspection is made within the enclosures. The water which can have entered the enclosure shall not have reduced **clearances** and **creepage distances** below the minimum values specified in Clause 29.*

If ducts leading to the outside of a building are used, the test of 15.2 is carried out on the terminations of such ducts in an arrangement simulating the actual installation, according to the instructions.

For appliances intended to be mounted through a wall or a window, or for a split unit, the test of 15.2 is carried out on that part or unit which, according to the instructions, is intended to be mounted outside the building.

*The motor-compressor is not operated and **detachable parts** are removed during the tests of 15.2 and 15.3.*

15.2 Appliances other than IPX0 are subjected to the tests of IEC 60529:1989 as follows:

- IPX1 appliances as described in 14.2.1;
- IPX2 appliances as described in 14.2.2;
- IPX3 appliances as described in 14.2.3;
- IPX4 appliances as described in 14.2.4;
- IPX5 appliances as described in 14.2.5;
- IPX6 appliances as described in 14.2.6;
- IPX7 appliances as described in 14.2.7.

For the IPX7 test, the appliance is immersed in water containing 1 % NaCl.

15.3 The appliance is installed in its position of normal use. The drain pan discharge pipe is blocked, and the pan carefully filled to the brim without splashing. The drain pan is then subjected to a continuous overflow, the rate of which is adjusted to approximately 17 cm³/s per 1 m³/s airflow, and the fan(s) switched on. The test is continued for a period of 30 min, or until all water drains from the appliance.

15.101 Spillage testing of indoor floor or wall-mounted **appliances accessible to the general public** are tested as follows.

The appliance is installed according to the installation instructions but not operated.

Covers which provide access for manual operation of electrical controls are set in the open position, unless such covers are of the self-closing type.

*A solution of 0,25 l of water containing approximately 1 % NaCl is poured onto the unit in a manner which is most likely to cause entrance of water into or on electrical controls or **uninsulated live parts**.*

After spillage is completed, the appliances shall withstand the tests of Clause 16.

The spillage test is not applicable to units if the minimum linear dimension of a horizontal or near horizontal top surface of the cabinet is 75 mm or less.

A unit whose top, when installed, has a height of greater than 2 m need not be tested.

NOTE The intent is that a 75 mm diameter glass cannot be placed on the surface of the appliance and spill.

16 Leakage current and electric strength

This clause of Part 1 is applicable except as follows.

16.2 Modification:

*For **stationary class I motor-operated appliances**, the leakage current shall not exceed 3,5 mA, or 2 mA per kilowatt **rated power input**, whichever is higher. The maximum value shall not exceed 10 mA for **appliances accessible to the general public** and 30 mA for **appliances not accessible to the general public**.*

17 Overload protection of transformers and associated circuits

This clause of Part 1 is applicable.

18 Endurance

This clause of Part 1 is not applicable.

19 Abnormal operation

This clause of Part 1 is applicable except as follows.

19.1 Modification:

Add after the second paragraph:

Failure of the transfer medium flow, or of any control devices, shall not result in a hazard.

Replace the 1st and 2nd paragraphs of the test specification by the following:

Appliances are subjected to the tests specified in 19.2 to 19.10, 19.101, 19.102, 19.103, and 19.104 as applicable.

19.2 Addition:

*This subclause of Part 1 is not applicable for appliances with **supplementary air heaters**.*

19.3 Addition:

*This subclause of Part 1 is not applicable for appliances with **supplementary air heaters**.*

19.4 Addition:

*The appliance is operated under the conditions in Clause 11 and at **rated voltage**, with any form of operation or any defect that can be expected during normal use. Only one fault condition is reproduced at a time, the tests being made consecutively.*

Examples of fault conditions are

- the timer, if any, stopping in any position;*
- disconnection and reconnection of one or more phases of the supply;*
- open-circuiting or short-circuiting of components, like relays, contactors, timers, **thermostats**, etc.*

In general, tests are limited to those cases which are expected to give the most unfavourable results.

19.7 Modification:

Replace the first paragraph, ending with "...other appliances" by:

The motors, other than motor-compressors and stationary circulation pumps in compliance with IEC 60335-2-51, are mounted on a support of wood or similar material. The motor rotors are locked; fan blades and brackets are not removed.

*The motors are supplied at their supplied voltage when the appliance is supplied at **rated voltage** or at the upper limit of the **rated voltage range**, in a circuit as shown in Figure 103. Care shall be taken to complete the earthing system to permit the correct operation of the RCCB/RCBO.*

*Under these conditions, the motor is operated for 15 days (360 h) or until a **protection device** permanently opens the circuit, whichever is the shorter period.*

During the test, the ambient temperature is maintained at $23\text{ °C} \pm 5\text{ °C}$.

If the temperature of the motor windings does not exceed 90 °C when steady conditions are established, the test is considered to be ended.

During the test, the temperature of the enclosure shall not exceed 150 °C and the temperature of the windings shall not exceed the values shown in Table 8.

Three days (72 h) after the beginning of the test, the motor shall withstand an electric strength test as specified in 16.3.

*At the end of the test, the leakage current, when measured as specified in 16.2 but with a test voltage of twice the **rated voltage** between all windings and the enclosure, shall not exceed 2 mA.*

NOTE 101 Only for this test specified in 19.7 of this standard, the motor is locked and operated for 15 days (360 h) or until a protection device permanently opens the circuit. It is not the intention to repeat the 15-day locked rotor test up to two more times for motors having capacitors in the circuit of an auxiliary winding. Hence for all tests according to 19.7 of Part 1, the motor is operated under the conditions specified in 19.7 of Part 1, including the time specifications.

Add after the last paragraph:

If the motor-compressor has not been type-tested against the requirements of IEC 60335-2-34, then it shall be subject to the following test.

A sample shall be provided with the rotor locked and being filled with oil and refrigerant as intended. The sample shall then be subjected to the tests specified in 19.101, 19.102, 19.103 and 19.105 of IEC 60335-2-34:2021, if applicable, and shall comply with the requirements in 19.104 of IEC 60335-2-34:2021.

19.8 Replacement:

*Three phase motors other than motor-compressors are operated under the conditions of Clause 11 at **rated voltage** or at the upper limit of the **rated voltage range** with one phase disconnected, until steady conditions are obtained or the **protective device** operates.*

19.9 This subclause of Part 1 is not applicable for motor-compressors, stationary circulation pumps in compliance with IEC 60335-2-51, and fans.

19.11.4 Modification:

Add before the first paragraph:

The first paragraph of Part 1 is not applicable if unintentional operation does not cause any hazards.

Replace the second paragraph by the following:

*Appliances incorporating a **protective electronic circuit** are subjected to the tests of 19.11.4.1 to 19.11.4.7. The tests are carried out after the **protective electronic circuit** has operated during the relevant tests of Clause 19, except 19.2, 19.6, 19.11.3, 19.102 and 19.103.*

*If the appliance incorporates more than one **protective electronic circuit**, each **protective electronic circuit** shall be tested individually with the appliance operated under **normal operation** at any temperature within the working range.*

*It is not necessary for a component protected by a **protective electronic circuit** that has been previously tested and shown to comply with the requirements of 19.11.4 of its standard to be retested in the final application.*

NOTE 101 Components can be for example motor-compressors, fans and circulating pumps.

NOTE 102 Test results of 19.11.4.1, 19.11.4.2 and 19.11.4.3 can possibly be influenced by the wiring and the metal housing of the final application. Therefore, the best moment to perform these tests is once in the final application.

NOTE 103 **Protective electronic circuit** (PEC) operation is understood as the operation that stops the component(s) operation controlled by the PEC with the intention to prevent the hazardous situation.

Add, after the last paragraph of the test specification, the following:

For these tests, it can be necessary to provide specially prepared component samples, e.g. compressors with locked rotor.

19.11.4.8 Modification:

Add to the end of the first sentence:

"at any temperature within the working range."

19.13 Modification:

Table 9 – Maximum abnormal temperature rise

Addition:

Part	Temperature rise K
Surfaces of product, discharge plenum, and duct at points of specified zero clearance to test casing	150
Surfaces of test casing where clearance more than zero to combustible material is specified	150

Footnote a of Table 9 is not applicable.

19.14 Modification:

Add before the last paragraph:

Locking in the "on" position of the main contacts of a contact intended for switching on and off the heating element(s) in normal use is considered to be a fault condition, unless the appliance is provided with at least two sets of contacts connected in series. For example, by providing two contactors operating independently of each other or by providing one contactor having two independent armatures operating two independent sets of main contacts.

19.101 The appliance is operated under the conditions in Clause 11 at **rated voltage** or at the upper limit of the **rated voltage range**, at an ambient temperature of $23\text{ °C} \pm 5\text{ °C}$. When steady conditions are attained, the heat transfer medium flow of the **outdoor heat exchanger** is restricted or shut off, whichever is the most unfavourable without the appliance being non-operative.

After this test, **protective devices** that have operated are reset, and the test is repeated, with the heat transfer medium flow, fluid or air, of the **indoor heat exchanger**, restricted or shut off, whichever is the most unfavourable without the appliance being non-operative. In the case of appliances with defrosting systems, the heat transfer medium flow rate is additionally shut off at the beginning of the defrosting phase.

Appliances incorporating a motor common to both the **indoor heat exchangers** and **outdoor heat exchangers** are subjected to the above test, the motor being disconnected once steady conditions are attained.

19.102 The **indoor heat exchanger** of appliances using water as a heat transfer medium is subjected to the following test.

The appliance is operated under the conditions specified for Clause 10 at **rated voltage** or at the upper limit of the **rated voltage range** at the maximum water temperature specified by the manufacturer. The indoor water temperature shall be raised 15 K at a rate of 2 K/min and this temperature maintained for 30 min, after which the water temperature is lowered to its original value at the same rate.

19.103 Air to air appliances are operated under the conditions specified in Clause 11.

The **dry-bulb temperature** is then reduced to a value 5 K below the minimum value specified by the manufacturer.

The test is repeated except that the **dry-bulb temperature** is increased to a value 10 K above the maximum temperature specified by the manufacturer, but not to exceed 55 °C.

The appliances are operated at **rated voltage** or at the upper limit of the **rated voltage range**.

19.104 For appliances with **supplementary air heaters**:

19.104.1 General

Appliances provided with **supplementary air heaters** or provisions for **supplementary air heaters** are subjected to the test of 19.104.2 through 19.104.8 under the conditions specified in Clause 11 unless otherwise indicated.

All appliances with **supplementary air heaters** shall be configured with inlet and outlet ducts as applicable and instrumented in accordance with the applicable subclauses of Clause 11.

Appliances are tested in the **operating state** and configuration which give the most unfavourable results.

Appliances are operated at an ambient temperature of $23\text{ °C} \pm 5\text{ °C}$ and **rated voltage** or at the upper limit of the **rated voltage range** of the **supplementary air heaters**.

Tests shall be conducted with all the **supplementary air heater** heating elements activated as allowed by the unit controls with the thermostats over-ridden. If the unit controls do not allow all **supplementary air heater** heating elements to be activated by over-riding the thermostats, then the test shall be conducted with the thermostats over-ridden and the air temperature reduced to a value which causes all the elements to switch on.

For appliances with **supplementary air heaters**, the heat provided by the **heat pump** may be simulated by use of an alternate heating source equal to the capacity of the **heat pump** when operated under the conditions of Clause 11. If at any condition during the tests of 19.104 the **heat pump** operation is interrupted by a protective control, the alternate heat source shall be interrupted in the same way.

19.104.2 Restricted inlet – 1st limit cut-out

To test limit cut-out conditions, the airflow conditions specified are established, the indoor airflow is reduced by restricting the inlet air opening to a rate resulting in not more than 1 K/min outlet air temperature rise until a **self-resetting thermal cut-out** device operates for the first time as a result of slowly restricting the free area of the inlet.

The outlet air temperature, measured by means of the thermocouple grid, shall not exceed 90 °C.

19.104.3 Restricted inlet – minimum airflow

To test heating operation conditions, after the airflow conditions specified are established, the indoor airflow is reduced by restricting the inlet air opening to such an extent that the temperature of the air in the outlet is 3 K below the temperature obtained after a **self-resetting thermal cut-out** device operates for the first time as a result of slowly restricting the free area of the inlet.

The appliance shall be operated until steady state conditions are established or for 1 h, whichever is longer. During the test, the temperatures are monitored continuously and shall not exceed the values shown in Table 3.

To facilitate this test, the **self-resetting thermal cut-out** which has operated in 19.104.2 may be short-circuited, if necessary.

NOTE Tests of 19.104.4 can be conducted immediately after the tests of 19.104.2.

19.104.4 Restricted inlet – restrict inlet to fully blocked

To test restricted inlet conditions, after the airflow conditions specified are established, the indoor airflow is reduced by restricting the inlet air opening at a rate resulting in not more than 1 K/min outlet air temperature rise until a **self-resetting thermal cut-out** device operates.

The restriction shall be halted after any **protective device** operates until steady state conditions are established. After steady state conditions are reached, the restriction is resumed. The test shall continue until the inlet is fully restricted.

The temperatures are monitored continuously. Temperatures shall not exceed the values shown in Table 3 + 30 K during the first hour and Table 3 thereafter.

19.104.5 Fan failure

To test fan failure conditions, after steady state conditions are attained, heat transfer medium flow of the indoor **heat exchanger** is restricted or shut off, whichever is the most unfavourable without the appliance being non-operative.

Temperatures shall not exceed the values shown in 19.13.

19.104.6 Blocked outlet

To test blocked outlet conditions, when steady conditions are attained, the appliance outlet air opening is totally closed off and operation continued until maximum temperatures are determined.

This test with the outlet air opening closed shall not be conducted on any unit with free air discharge openings located more than 1,2 m above the floor level when the unit is installed as intended.

Temperatures shall not exceed the values in 19.13.

19.104.7 Curtain drape

All appliances provided with **supplementary air heaters** and with free air discharge openings are subjected to the following test in each mode of operation.

This test shall not be conducted on any unit with free air discharge openings located more than 1,8 m above the floor level when the unit is installed as intended.

Appliances are operated under the conditions specified in Clause 11, with any controls which limit the temperature during the test of Clause 11 short-circuited, and with the appliance covered.

The covering is made with felt strips each having a width of 100 mm and lined with a single layer of textile material.

The felt has a specified mass of $4 \text{ kg/m}^2 \pm 0,4 \text{ kg/m}^2$ and a thickness of 25 mm.

The textile material consists of a prewashed double-hemmed cotton sheet having a mass between 140 g/m^2 and 175 g/m^2 in the dry condition.

Thermocouples are attached to the back of small blackened disks of copper or brass, 15 mm in diameter and 1 mm thick.

The disks are spaced 50 mm apart and placed between the textile material and the felt on the vertical centre line of each strip.

The disks are supported in such a way as to prevent them from sinking into the felt.

The strips are applied with the textile material in contact with the appliance so that they cover the whole vertical dimension of the front, pass over the top and extend down the rear surface.

If the appliance is constructed to stand away from the wall or if it is for fixing to a wall so that the gap between the heater and the wall exceeds 30 mm and the horizontal components of the distance between any two fixing points or spacers or between such points and the end of the appliance exceed 100 mm, the rear surface of the appliance shall be completely covered.

Otherwise, the rear surface is covered over a distance approximately equal to one-fifth of the vertical dimension of the heater.

The strips are applied to each half of the appliance in turn and then to the complete appliance.

During the test, the temperature shall not exceed 150 °C except that an overshoot of 25 K is permitted during the first hour.

*Thermal **protective devices** are allowed to operate.*

19.104.8 Back up protection test

*If a **self-resetting thermal cut-out** operates during the tests of 19.104, then the **self-resetting thermal cut-out** shall be by-passed and the tests of 19.104.4 through 19.104.7 shall be repeated.*

For the test of 19.104.4, the rate of restriction shall be such that the opening is totally blocked at the end of 30 min.

Temperatures shall not exceed the values in 19.13.

19.105 For **dehumidifiers** in which the compressor is enclosed by a non-metallic material which isolates it from the forced air stream providing air to the **heat exchanger**, the following test shall apply.

The test shall be conducted under each of the following conditions:

- *with 75 % of the charge removed;*
- *with the system pressure less than 0,12 MPa, but not less than 0,10 MPa with the appliance de-energized.*

*The appliance shall be operated under the conditions of Clause 11 at the lower limit of the **rated voltage range** and an ambient temperature of 23 °C ± 5 °C. The appliance shall be operated until all components and the enclosure temperatures stabilize or are declining, but for not less than 24 h, or until the operation of the compressor is terminated by a non-self-resetting **protective device**. Any self-resetting **protective device** that actuates during this test shall be allowed to cycle as intended.*

Temperatures of non-metallic parts shall not exceed the relative thermal index of the material in accordance with IEC 60695-1-10.

Compliance is checked by test.

19.106 Double wall heat exchangers for **refrigerating systems** employing **flammable refrigerants** with **refrigerant charge** $m_c > m_1$ shall be resistant against freezing.

This requirement is not applicable to **double wall heat exchangers** which will only be exposed to temperatures above the freezing point of the secondary fluid.

NOTE 1 **Double wall heat exchangers** placed indoors in air-to-water **heat pumps** can be exposed to temperatures below 0 °C when defrosting using reverse cycle.

*Compliance is checked by confirming that not more than one of the **heat exchanger** walls is damaged or broken so that refrigerant leaks to the secondary circuit under the specified freezing conditions. Leaks between refrigerant and atmosphere are not critical.*

NOTE 2 Usually the separating walls of **double wall heat exchangers** are brazed together in some areas. At those brazing points freezing water can destroy both separating walls at once.

If the two walls separating secondary circuit and refrigeration circuit are brazed or welded together in some areas where water can be entrapped and break the heat exchanger by expansion due to freezing, then the test in Clause GG.6 item 2 a), b) and d) is performed in a refrigeration circuit with one of the safety measures to avoid freezing disabled. Each freezing cycle shall run for 5 min whether the compressor is switched off by a safety measure or not.

NOTE 3 A resistor can offset a temperature sensor to simulate a faulty sensor

The freezing test is repeated until a wall leaks, the control system detects an error, or 100 freezing cycles are completed, whichever occurs first.

During the test the refrigerant shall not leak into the secondary circuit.

NOTE 4 The failure of the **heat exchanger** can be recognized by monitoring the pressure of the secondary circuit if the secondary circuit is a closed loop and the saturated pressure of the refrigerant at the freezing point of the secondary fluid is above the pressure in the secondary circuit.

20 Stability and mechanical hazards

This clause of Part 1 is applicable except as follows.

20.1 Addition:

Fixed appliances that are only fixed into position by water piping, refrigerant piping or other piping are also subjected to this test.

Such pipes are not connected to the appliance during this test.

20.2 Addition:

Test probe 18 of IEC 61032 is not applied to parts of appliances that, according to the installation instructions, are required to be mounted at a height exceeding 1,8 m above the floor.

21 Mechanical strength

This clause of Part 1 is applicable except as follows.

21.1 Addition:

Pressure vessels shall comply with the requirements of ISO 5149-2:2014, 4.4.2.

The pressure test in Annex EE applies to parts other than **pressure vessels**.

21.2 Modification:

Add the following sentence after the second paragraph:

*For **accessible parts** made of **particle foam material** used as **supplementary insulation** or **reinforced insulation**, the following test is done without any consideration of the insulation thickness.*

21.101 Appliances using **flammable refrigerants** shall withstand the effects of vibration during transport.

The appliance is tested in its final packaging for transport, fixed to the vibration table, and shall withstand a random vibration test for 180 min according to ISO 13355 with the power spectral density profile specified in Table 101.

Table 101 – Power spectral density profile for vibration test

Frequency Hz	Level (m/s ²) ² /Hz
1	0,004 8
4	0,961 7
16	0,961 7
40	0,096 2
80	0,096 2
200	0,001 0
In between values are to be interpolated as shown in Figure 104.	
NOTE The RMS value is 5,1 m/s ² .	

Where testing to ISO 13355 is impractical due to limitations of available test facilities/equipment within the industry, the appliance shall be tested by a transport test representative of shipping mode such as truck, rail, air, and/or ocean. Truck transport test is mandatory. Rail, air, and/or ocean transport tests are optional.

The product shall be transported for a distance of not less than 2 times the longest expected transportation route as determined by the manufacturer in consideration of the product marketplace and distribution. For truck transport, at least 3 categories of roads shall be used, representing the expected transportation route with at least 10 % of the total distance for each road category.

Compliance is checked by the following:

- *the use of detection equipment having an equivalent sensitivity of 3 g/year of refrigerant shall reveal no leaks;*
- *damage of parts other than the refrigerating circuit is allowed.*

NOTE The test can be carried out on the appliance charged with a non-flammable refrigerant or a non-hazardous gas when pressurized to the saturated vapour pressure corresponding to a temperature of 23 °C.

21.102 Double wall heat exchangers for refrigerating systems employing **flammable refrigerant** with **refrigerant charge** $m_c > m_1$ shall be constructed in a way that they do not allow refrigerants to leak into the secondary circuit if one of the walls breaks.

Each of the two walls separating secondary circuit and refrigeration circuit shall withstand the pressure test of Annex EE. In case of vented intermediate chamber, only the wall on the refrigerant side shall withstand the pressure test of Annex EE.

Compliance is checked by the pressure test of Annex EE, which is carried out

- on a closed intermediate chamber: with one wall broken in turn;
- on a vented intermediate chamber: only on the refrigerant side.

22 Construction

This clause of Part 1 is applicable except as follows.

22.6 Addition:

The electrical insulation shall not be affected by snow which might enter the appliance enclosure.

22.14 Addition:

This requirement does not apply to the metallic fins of **heat exchangers**.

22.24 Replacement:

Bare heating elements shall be supported so that, in case of rupture or sagging, the heating conductor cannot come into contact with accessible metal parts nor give rise to a hazard. Bare heating elements shall not be used with wood or wood composite enclosures.

Compliance is checked by inspection and, if necessary, by cutting the element in the most unfavourable place. No force shall be applied to the conductor after it has been cut.

This test shall be made after the tests of Clause 29.

22.40 Modification:

The second paragraph is not applicable.

22.49 Replacement:

Not applicable.

22.51 Replacement:

Not applicable.

22.101 Appliances intended to be fixed shall be so designed that they can be securely fixed and maintained in position.

Compliance is checked by inspection and in case of doubt, after installation of the appliance, in accordance with the installation instructions.

22.102 For appliances provided with **supplementary heaters**:

22.102.1 Appliances provided with **supplementary air heaters** shall be provided with at least two **thermal cut-outs**. The **thermal cut-out** intended to operate first shall be either a **self-resetting thermal cut-out** or a **non-self-resetting thermal cut-out**; the other **thermal cut-out** shall be a **non-self-resetting thermal cut-out**.

Compliance is checked by inspection and during the tests of Clause 19.

22.102.2 Appliances provided with **supplementary water heaters** shall incorporate a **non-self-resetting thermal cut-out**, providing **all-pole disconnection** that operates separately from water **thermostats**. However, for appliances intended to be connected to fixed wiring, the neutral conductor need not be disconnected.

Compliance is checked by inspection and during the tests of Clause 19.

NOTE Anti-frost heaters are not considered to be **supplementary water heaters**, if it is not possible to heat up the water to a temperature higher than 80 °C at the highest operating temperature within 6 h, with the temperature switch short circuited and with water flow stopped.

22.102.3 Thermal cut-outs of the capillary type shall be so designed that the contacts open in the event of leakage from the capillary tube.

Compliance is checked by inspection and test.

22.103 The sensing and switching elements of electromechanical **non-self-resetting cut-outs** shall be functionally independent of other control devices. If the switching element of a **non-self-resetting cut-out** is operating a relay or contactor, the relay or contactor may also be operated by other control devices. **Protective electronic circuits** are covered by Clause 19.

Compliance is checked by inspection.

22.104 Containers of **sanitary hot water heat pumps** shall withstand the water pressure occurring in normal use.

*Compliance is checked by subjecting the containers and **heat exchangers**, if any, to a water pressure which is raised to the value specified below at a rate of 0,13 MPa per second and is maintained at that value for 5 min.*

The water pressure is

- twice the **maximum allowable pressure** for closed containers;
- 0,15 MPa for open containers.

After the test, no water shall have leaked out and the containers shall not have ruptured.

NOTE If the container of **sanitary hot water heat pumps** incorporates a **heat exchanger**, the container and the **heat exchanger** are subjected to the pressure test in accordance with the relevant standard.

22.105 In the case of closed containers of **sanitary hot water heat pumps**, the formation of an air or vapour cushion of more than 2 % of the capacity, but not more than 10 %, shall be provided.

Compliance is checked by inspection and, where necessary, by measurements.

22.106 Pressure-relief devices, whether incorporated in the container of **sanitary hot water heat pumps** or supplied separately, shall prevent the pressure in the container from exceeding the **maximum allowable pressure** by more than 0,1 MPa.

Compliance is checked by subjecting the container to a slowly increasing water pressure and by observing the pressure at which the relief device operates.

22.107 The outlet system of open containers of **sanitary hot water heat pumps** shall be free from obstructions that could limit the water flow to such an extent that the pressure in the container would exceed the **maximum allowable pressure**.

Vented containers of **sanitary hot water heat pumps** shall be so constructed that the container is always open to the atmosphere through an aperture of at least 5 mm in diameter or 20 mm² in area, with a width of at least 3 mm.

Compliance is checked by inspection and measurement.

NOTE The first requirement is considered to be met if the area of the water outlet from the heated part of the container of **sanitary hot water heat pumps** is equal or greater than the area of the water inlet to the heated part.

22.108 Storage tanks of **sanitary hot water heat pumps** shall be resistant to vacuum pressure impulses which can occur in normal use.

Compliance is checked by subjecting containers which are not vented, in accordance with 22.104, to a vacuum of 33 kPa for 15 min.

After the test, the container shall show no deformation which might result in a hazard.

Anti-vacuum valves, if any, are not rendered inoperative.

NOTE This test can be carried out on separate containers.

22.109 Wiring connected to a **non-self-resetting thermal cut-out** designed to be replaced after its operation shall be so secured that replacement of the **thermal cut-out** itself or to a heating element assembly on which the **thermal cut-out** is mounted will not damage other connections or internal wiring.

Compliance is checked by inspection and, if necessary, by manual test.

22.110 **Non-self-resetting thermal cut-outs** designed to be replaced after their operation shall open the circuit in the intended manner without short-circuiting **live parts** of different potential and without causing **live parts** to come into contact with the enclosure.

Compliance is checked by the following test.

*The appliance is operated five times, each time with a new **non-self-resetting thermal cut-out**, any other thermally operated control devices being short-circuited.*

*Each time, the **non-self-resetting thermal cut-out** shall operate appropriately.*

During the test, the enclosure of the appliance is connected to earth through a 3 A fuse; this fuse shall not blow.

After this test, the supplementary heating elements shall withstand an electric strength test as specified in 16.3.

22.111 Void.

22.112 The construction of the **refrigerating system** shall comply with the requirements of ISO 5149-2:2014, 4.2, 4.3, 5.2.1, 5.2.2, 5.2.4, 5.2.5, 5.2.15, 5.2.6.1, 5.2.6.3, 5.2.7, 5.2.8, 5.2.9.1, 5.2.9.3, and 5.2.9.4, ISO 5149-2:2014 and ISO 5149-2:2014/AMD1:2020, 5.2.3, and ISO 5149-2:2014/AMD1:2020, 4.1, 5.2.9.2.

NOTE A **safety shut-off valve** is an isolating valve for the purpose of ISO 5149-2.

Compliance is checked by inspection.

22.113 When a **flammable refrigerant** is used, refrigerant piping shall be protected or enclosed to avoid mechanical damage. The refrigerant piping shall be protected to the extent that it will not be handled or used for carrying during moving of the appliance. Refrigerant piping located within the appliance enclosure is considered to be protected from mechanical damage.

Compliance is checked by inspection.

22.114 When a **flammable refrigerant** is used, low temperature solder alloys, such as lead/tin alloys, shall not be used for pipe connections or any other refrigerant pressure containing purposes.

Compliance is checked by inspection.

22.115 The **refrigerant charge** (m_c) in each **refrigerating system** employing **flammable refrigerant** shall not exceed m_3 as defined in Annex GG.

The construction of the **refrigerating system** using **flammable refrigerants** shall comply with the requirements in Annex GG.

Compliance is checked by inspection.

22.116 For arcs and sparks from electric components:

22.116.1 Appliances using **flammable refrigerants** shall be constructed so that any leaked refrigerant will not flow or stagnate so as to cause a fire or explosion hazard in areas within the appliance or connected ducts where electrical components, which could be a source of ignition and which could function during **normal operation** or as a result of a leak, are located.

NOTE **Thermal cut-outs** and similar devices are not considered to function during **normal operation**.

Separate components, such as **thermostats**, which are charged with less than 0,5 g of a flammable gas are not considered to cause a fire or explosion hazard in the event of leakage of the gas within the component itself.

*Electrical components, which are potential ignition sources that could function under **normal operation** or as a result of a leak, are not considered a source of ignition if they comply with at least one of the following requirements:*

- a) *not be located in an area where a potentially flammable gas mixture will accumulate as demonstrated by the test of Annex FF;*
- b) *have equipment protection level according to 22.116.2;*
- c) *are sealed components in compliance with the tests of 22.116.3, and protected from impact by the appliance enclosure;*
- d) *are located in an enclosure which complies with IEC 60079-15:2017, Clause 7 through Clause 10, for restricted breathing enclosures suitable for use with group IIA gases or the refrigerant used;*
- e) *are located in an enclosure which complies with Annex NN. Applicable to appliances with **A2L refrigerants** only;*

- f) *are in compliance with Annex JJ. Applicable to appliance with **A2L refrigerants** only;*
- g) *are in compliance with 22.116.4. Applicable to appliance with **A2L refrigerants** only;*
- h) *electrostatic air cleaners or similar devices tested and found to comply with 22.116.5. Applicable to appliance with **A2L refrigerants** only;*
- i) ***refrigerant sensors** tested and found to comply with IEC TS 63542:2024.*

22.116.2 Components are not considered to be ignition sources if they comply with the requirements for equipment protection level Ga, Gb, or Gc as defined in IEC 60079-14 for the refrigerant used in the appliance or the relevant gas group (IIA, IIB, or IIC) to which the refrigerant belongs. However, the following requirements do not apply:

- marking requirements of the applicable standard in IEC 60079 (all parts);
- the impact tests of IEC 60079-0;
- the IP test of IEC 60079-0;
- the drop test of IEC 60079-0;
- the creepage and **clearance** requirements in IEC 60079-7.

NOTE 1 Most refrigerants belong to group IIA gases, however R-E170 belongs to group IIB gases.

NOTE 2 Examples of relevant protection principles that can be applied:

- Non incensive components "nC" in IEC 60079-15:2017.
- Flameproof "dc" in IEC 60079-1:2014 (formerly enclosed break device "hC" in IEC 60079-15:2010).
- Increased safety "ec" in IEC 60079-7:2015 and IEC 60079-7:2015/AMD1:2017 (formerly non sparking low power equipment "nA" in IEC 60079-15:2010).
- Intrinsic safety "ic" in IEC 60079-11:2011 (formerly energy limited apparatus "nL" in IEC 60079-15:2010).
- Sealed device "nC" in IEC 60079-15:2017.
- Hermetically sealed device "nC" in IEC 60079-15:2017.
- Restricted breathing enclosure "nR" in IEC 60079-15:2017.

Compliance is checked by inspection or testing as required by the relevant IEC 60079 series standard.

22.116.3 *Three samples of the component shall be conditioned in a climate chamber for 168 h at the maximum operating temperature during the test of Clause 11 plus 12 K, but not less than 75 °C. This conditioning is followed by 24 h at the minimum operating temperature during the test of Clause 11 reduced by at least 5 K.*

The test temperature in the climate chamber shall be maintained within 2 K for the duration of the test.

The components shall be stabilized at a temperature of 25 °C. The entire components shall then be rapidly immersed in water at a temperature of (50 ± 2) °C to a depth of at least 25 mm below the surface for at least 60 s.

No bubbles shall emerge from the inside of the samples during this test.

22.116.4 For **A2L refrigerants**, devices capable of 100 000 cycles according to Clause 24 switching AC loads in compliance with one of the following are not considered a potential ignition source:

- for resistive loads where the impedance has a power factor higher than 0,99: Breaking current per contact is not more than 48 A during **normal operation**;

- for inductive loads where the power factor is not more than 0,99, the apparent power (S) of the switched inductive electrical load per phase in kVA is less than or equal to:

- $L_e = 5 \times (6,7/S_u)^4$ when breaking all phases of a 3 phase load;
- $L_e = 2,5 \times (6,7/S_u)^4$ all others.

where

L_e is the maximum allowed apparent power of the switched inductive electrical load in kilovoltamperes (kVA);

S_u is the burning velocity of a refrigerant in centimetres per second (cm/s).

Compliance is checked by measurement.

22.116.5 For appliances with **A2L refrigerants**, electrostatic air cleaners and similar devices which can produce electrical arcing during **normal operation** that could ignite the refrigerant used, and which are installed in the unit airstream or connecting ducts, are not considered as a potential ignition source if the airflow is monitored and the energy source of the electric arcing is switched off when the airflow is below the minimum airflow according to Clause GG.9.

Compliance is checked by inspection and, if necessary, by an appropriate test.

22.116.6 For the purpose of determining the maximum quenching diameter (d_q) in Annex JJ and the maximum switched inductive electrical load L_e (see 22.116.4), the effect of humidity on burning velocity (S_u) shall be taken into consideration.

The burning velocity (S_u) shall be the highest value of

- as specified in ISO 817; or
- as measured in humid air at $27\text{ °C} \pm 0,5\text{ °C}$ dew point at 101,3 kPa containing $21,0\% \pm 0,1\%$ O_2 excluding water vapour determined at the nominal composition as specified in ISO 817.

NOTE The 27 °C dew point equates to an absolute humidity of 0,022 7 kg water vapour per 1 kg dry air.

This test can be done at the temperature higher than 27 °C . The required dew point is only for humidity.

The burning velocity (S_u) at 27 °C dew point may be determined by extrapolation of the measurement at 23 °C and 50 % relative humidity and the burning velocity (S_u) as provided by ISO 817. The extrapolation shall be based on the measured value increased by the measurement uncertainty to the burning velocity (S_u) at 23 °C and 50 % relative humidity. If the burning velocity (S_u) is not measurable at dry condition, the burning velocity shall be measured at 27 °C dew point.

22.117 For hot surfaces:

22.117.1 Temperatures on surfaces that can be exposed to leakage of **flammable refrigerants** in excess of 25 % of **LFL** as determined in Annex FF shall not exceed the maximum allowable surface temperature given in Annex BB.

For A2 and A3 refrigerants not listed in Annex BB, the maximum allowable surface temperature is the **AIT**.

For **A2L refrigerants** not listed in Annex BB, the maximum allowable surface temperature is determined by the higher of **AIT** or, if tested per Annex KK, the **hot surface ignition temperature** reduced by 100 K.

*Compliance is checked by measuring the appropriate surface temperatures during the tests of Clause 11 and Clause 19, except those which during the tests of Clause 19 are terminated in a non- self-resetting way. Compliance for **A2L refrigerants** is checked by measuring the appropriate surface temperatures during the tests of Clause 11.*

Surfaces in compliance with 22.117 shall not be considered a potential ignition source.

Refrigerant sensors tested and found to comply with IEC TS 63542:2024 are considered to comply with 22.117.

22.117.2 Temperatures on surfaces that can be exposed to leakage of **A2L refrigerants** may exceed the maximum allowable surface temperature in case of loss of airflow when all the following applies:

- the temperatures are not exceeding the maximum allowable surface temperature with the minimum airflow;
- the airflow is supervised and the heat source of the hot surface is switched off, when the airflow is below the minimum airflow.

NOTE Proof of airflow can be provided by any reliable means, including detection of fan speed.

Compliance is checked by inspection and by measuring the appropriate surface temperatures during the tests of Clause 11.

22.117.3 Open sources of ignition, including open flames, pilot flames, direct spark ignition or hot surface ignition or other similar sources of ignition in the combustion air-stream, if the combustion air is drawn from an unventilated space in which leaked refrigerant can enter through the combustion air intake, are allowed, when these appliances are provided with a flame arrestor or equivalent to ensure that in the event of an ignition, the flame will not propagate.

Compliance is checked by inspection.

22.118 Joints made in the installation between parts of the **refrigerating system**, with at least one part charged, shall be made in accordance with the following.

- A brazed, welded, or mechanical connection shall be made before opening the valves to permit refrigerant to flow between the **refrigerating system** parts. A vacuum valve shall be provided to evacuate the interconnecting pipe and/or any uncharged **refrigerating system** part.
- Mechanical connectors used indoors shall comply with ISO 14903. When mechanical connectors are reused indoors, sealing parts shall be renewed. When flared joints are reused indoors, the flare part shall be re-fabricated.
- Refrigerant tubing shall be protected or enclosed to avoid damage.

Flexible refrigerant connectors (such as connecting lines between the indoor and outdoor unit) that can be displaced during **normal operation** shall be protected against mechanical damage.

Compliance is checked according to the installation instructions and a trial installation if necessary.

22.119 **Condensing units** and **evaporating units** shall be equipped with a **pressure-limiting device** or equivalent to ensure that the equipment does not exceed the **maximum allowable pressure**.

NOTE Applies to **partial unit** types, **condensing units** and **evaporating units** only.

For **partial units**, the interconnection circuits for signal communication between each unit shall be of the same type.

SELV connection is recommended.

Compliance is checked by inspection.

22.120 Partial units shall be provided with a means of connection to the supply mains and shall not be powered by an electrical circuit from another appliance.

Compliance is checked by inspection.

22.121 For **leak detection system** sensor location:

22.121.1 For the installation condition of appliances using an **A2L refrigerant** and where a **leak detection system** is applied to fulfil the requirements of Annex GG or for the purpose of limiting **releasable charge**, the **refrigerant sensor** shall be:

- within the unit for appliances connected via an air duct system to one or more rooms,
- within the ventilated enclosure if in compliance with Clause GG.4,
- within the unit where release height h_0 as determined in Clause GG.2 is not more than 1,5 m,
- where the release height h_0 as determined in Clause GG.2 is more than 1,5 m, located within
 - the unit, or
 - 100 mm or less directly below the unit, or
 - remote located within 300 mm above the floor. If a remote located **refrigerant sensor** is specified by the manufacturer, the instructions shall state that the **refrigerant sensor** shall be located within
 - i) 10 m horizontal distance in line sight of the unit and on a wall within the room in which the unit is installed, or
 - ii) 7 m, if not in line sight of the unit, and on a wall within the room in which the unit is installed. The distance from the unit to the **refrigerant sensor** shall be measured as the shortest horizontal unobstructed path between the unit and the nearest **refrigerant sensor**.

For installations with field applied mechanical joints which are exposed in the occupied space, the instructions shall state that a **refrigerant sensor** shall be

- remote located within 2 m horizontal distance in line of sight of the unit and on a wall within the room in which the unit is installed; and
 - 100 mm above the floor where h_0 is not more than 300 mm from the floor; or
 - 300 mm above the floor where h_0 is greater than 300 mm from the floor.

The following field mechanical joints shall not require a **refrigerant sensor**:

- mechanical joints in compliance with ISO 14903;
- joints in enclosures which vent to the unit or to the outside;
- joints in enclosures which vent to a room with a minimum room area as specified in GG.2.1.

NOTE 1 A single **refrigerant sensor** can be used if it satisfies all of the requirements for the unit and the field applied joints.

NOTE 2 The appliance can have several **refrigerant sensors** in different locations to comply with this standard.

*Compliance is checked by inspection and by testing in accordance with Annex MM or Annex PP. Testing according to Annex MM and Annex PP is not required when the **leak detection system** is only used for reducing the **releasable charge** as determined by Annex QQ. Remote located **refrigerant sensor** location is not tested. **Refrigerant sensors** located 100 mm or less directly below the unit are not considered remote **refrigerant sensors**.*

NOTE 3 Subclause QQ.5.1 specifies when Annex MM or Annex PP are applicable for Clause QQ.3 and Clause QQ.4.

22.121.2 For the installation condition of appliances using an A2 or A3 refrigerant and where a **leak detection system** is applied to fulfil the requirements of Annex GG or for the purpose of limiting **releasable charge**, the **refrigerant sensor** shall be within or part of the unit.

For appliances with ventilated enclosure in compliance with Clause GG.4, the **refrigerant sensor** shall be within the ventilated enclosure.

NOTE More than one **refrigerant sensor** can be used to comply with the requirements of Annex GG.

*Compliance of **leak detection system refrigerant sensor** location is checked by inspection and by testing in accordance with Annex PP. Testing according to Annex PP is not required when the **leak detection system** is only used for reducing the **releasable charge** and the appliance has been tested for compliance with Annex QQ.*

For installations with field applied joints which are exposed in the occupied space, these joints shall require at least one of the following:

- mechanical joints in compliance with ISO 14903;
- welded or brazed joints;
- joints in enclosures which vent to the unit or to the outside.

Compliance is checked by inspection and tests.

22.122 For **refrigerant detection systems** that are required by this standard for **flammable refrigerants**, the following applies:

- the output signal of the **refrigerant detection system** shall activate the actions required to comply with Annex GG in the event of a leak;
- where a **refrigerant detection system refrigerant sensor** is used to activate safety measures in multiple units in the same room, all of the detection system activated safety measures shall be applied to those units in the room which rely on that **refrigerant detection system**;
- if a **refrigerant detection system** or appliance provides notification that replacement of the **refrigerant sensor** is required (see IEC TS 63542:2024), then the user shall be notified and resetting this notification shall only be possible when the **refrigerant sensor** has been replaced.

Refrigerant detection system shall comply with IEC TS 63542:2024.

Compliance is checked by inspection and tests according to IEC TS 63542:2024.

22.123 For appliances using a **flammable refrigerant** according to Clause GG.9, which include a separate section with refrigerant containing components except pipes (e.g. compressors, **condensers**), and is located in a room smaller than $A_{\min}$ per Clause GG.2, that section shall:

- not be isolated from the indoor air stream, where a leak will be detected, or
- be ventilated to the outdoors in compliance with Clause GG.4, or
- be naturally ventilated to outdoors.

Compliance is checked by inspection.

22.124 Void

22.125 Refrigerating systems that fulfil all of the following conditions may be considered **enhanced tightness refrigerating systems**:

- a) Compressors, pressure relief devices and **pressure vessels** of the **refrigerating system** shall be located in locations other than the occupied space.
- b) Refrigerant distribution assemblies shall meet all applicable requirements of this standard.
- c) **Refrigerating systems** shall use only permanent joints indoors except for site-made joints directly connecting the indoor unit to the refrigerant piping, or factory-made mechanical joints in compliance with ISO 14903.
- d) Refrigerant containing parts in indoor units shall be protected from damage in the event of catastrophic failure of moving parts, e.g. fans, belts.
- e) Refrigerant containing pipes in the occupied space in question are installed in such a way that they are protected against accidental damage.
- f) The **refrigerating system** of each indoor unit shall be tightness tested at the factory with detection equipment with a capability of 3 grams per year of refrigerant or less under a pressure of at least 0,25 times the **maximum allowable pressure**. No leak shall be detected.

Compliance for bullet a) to bullet f) is checked by inspection.

- g) Vibrations exceeding 0,30 G RMS, when measured with a low pass filter at 200 Hz, are not allowed in the refrigerant containing parts in the occupied space under **normal operation**.

Compliance is checked by testing:

The equipment shall be mounted per installation instructions. The outdoor unit shall be directly connected to the indoor unit by the shortest line set per the installation instructions. Testing shall be conducted in fan only mode, heating mode and cooling mode if applicable.

Vibration level shall be measured over the full range of the compressor and indoor fan speeds as allowed by the controls in consideration of the operation modes. Care shall be taken that the measurement sensors do not influence the line vibration level, and that the rate of change of speed is sufficiently slow that the maximum vibration is captured.

- h) **Indoor heat exchangers** shall be protected from damage in the event of freezing.

Compliance is checked as follows:

- *Coils protected by controls. Compliance is checked by inspection; if in doubt, the test for non-freezing coils shall be executed.*
- *Non-freezing coils. Compliance is checked by conducting the minimum cooling performance test as described in ISO 5151, ISO 13253, ISO 15042, or the ISO 13256 series.*
- *Freezing coils. Compliance is checked on 3 samples by testing as follows. Cycling testing of the **heat exchanger** under frosting conditions confirms that the **heat exchanger** has adequate strength to withstand freezing without failure. The appliance shall cycle as intended by the controls for 10 days. At the end of the test, the **heat exchanger** shall withstand the strength requirements of Annex EE.*

- i) The maximum speed of the indoor fan, in **normal operation**, shall be less than 90 % of the maximum allowable fan speed as specified by the manufacturer of the fan wheel. If the manufacturer does not specify a maximum allowable fan speed, then the fan wheel shall be tested as follows:

The maximum allowable fan speed shall be established by running continuously at 120 % of maximum speed for 10 days. There shall be no structural failure of the fan.

If non-metallic fan wheels have a minimum thermal index rating of 65 °C per ISO 2578, preconditioning is not required.

If no thermal index rating for the material is available, specimens shall be aged at 90 °C for 168 h. The samples shall not have more than a 50 % reduction of the unconditioned property values for items 1) to 4) below:

- 1) tensile strength in accordance with ISO 527-3,
- 2) flexural strength in accordance with ISO 178,
- 3) Izod impact in accordance with ISO 180,
- 4) tensile impact in accordance with ISO 8256.

Compliance is checked by inspection and testing.

22.126 For the purpose of this standard, **UV-C germicidal lamp systems** are limited to low pressure mercury lamps with a quartz envelope having a continuous spectral irradiance at 254 nm.

NOTE The quartz envelope blocks the 185 nm resonant wavelength for mercury that can generate ozone.

Compliance is checked by inspection.

22.127 The appliance enclosure, **UV-C lamps** and **UV-C barriers** shall be located in such a manner that the **UV-C spectral irradiance** is not emitted outside the unit into an occupied space at a level exceeding the irradiance limit specified in 32.101.1.

Compliance is checked by inspection and test per 32.101.

*The appliance indoor airflow inlet and outlet shall be considered as possible radiation paths. The unit filters are not considered **UV-C barriers**.*

22.128 For appliances that employ **UV-C germicidal lamp systems** and which have doors and/or panels that provide direct access to an area within the appliance where the measured **UV-C spectral irradiance** is greater than 1,7 µW/cm², the doors and/or panels shall be equipped with an interlock device that terminates the power to the lamps when opened.

Compliance is checked by inspection, manual test, and test per 32.101.

*If a switch is used to de-energize the **UV-C lamps** so as to meet the requirement, it shall not be possible to operate the switch with test probe B of IEC 61032.*

22.129 For **user maintenance** access areas, the **UV-C spectral irradiance** shall not exceed the limit specified in 32.101.2 with the access panels opened or removed as needed to perform the required **user maintenance**. Panels that are opened or removed to perform **user maintenance** shall be required to be closed or put back in place for proper operation of the appliance.

Compliance is checked by inspection and test per 32.101.

22.130 If the replacement of the **UV-C lamp** is allowed by the user, the appliance shall be constructed so that

- the replacement of the **UV-C lamp** is easily possible;
- if screws or components are omitted or incorrectly positioned or fastened, the appliance is rendered inoperable or manifestly incomplete.

Compliance is checked by inspection.

22.131 Appliances that employ refrigerants in a **transcritical refrigerating system** shall be equipped with a **pressure-limiting device** that operates no greater than the **maximum allowable pressure** taking into account the tolerance of the **pressure-limiting device**.

Compliance is checked by inspection.

22.132 Safety shut-off valves for flammable refrigerants for the purposes of limiting the **releasable charge** shall default to fully closed position when the appliance is de-energised for any reason other than failure of the supply mains.

NOTE 1 If the appliance is powered through a **supply cord** fitted with a plug, then disconnecting this plug is not considered a failure of the supply mains.

NOTE 2 Backup power can be utilized to close motor driven valves, for instance capacitors or batteries.

Safety shut-off valves that are activated by a **leak detection system** shall have either

- manual operation for resetting which requires the aid of a **tool**, or
- automatically reset after the **leak detection system** has not detected refrigerant for at least 2 h.

For **refrigerating systems** using A2 or A3 refrigerants, **safety shut-off valves** shall be factory fitted in the appliance.

Compliance is checked by inspection.

The total seat leak rate for the refrigerant used for all the **safety shut-off valves** that reduce the leak into the same space shall be no more than m_{sv} :

$$m_{sv} = 4 \times LFL \quad (102)$$

where

m_{sv} is total seat leak rate in gram per second (g/s);

LFL is the **lower flammability limit** in kilogram per cubic metre (kg/m³);

4 is a constant.

NOTE 3 m_{sv} is the total leak rate released into the room through the **safety shut-off valves** if there is a leak in the indoor parts.

NOTE 4 The formula for m_{sv} is based on a maximum **refrigerant charge** of m_3 for **refrigerating systems** using **A2L refrigerants** and m_2 for **refrigerating systems** using A2 or A3 refrigerants.

Compliance is checked by the following test.

The **safety shut-off valve** shall be subjected to a cycle test, where it is opened and closed a number of times depending on its intended function:

- a **safety shut-off valve** activating in parallel with compressor cycling: 100 000 cycles;
- a **safety shut-off valve** activating only in response to a **leak detection system** and when appliance is de-energised: 1 000 cycles.

Before and after this cycle test, the seat leakage shall pass the test below, where the leakage rate at each of the tested pressures shall be no more than m_{sv} .

Seat leakage shall be measured, at the valve outlet port at all of the following pressures applied to the valve inlet for 1 min:

- $0,02 \times$ **maximum allowable pressure**;
- $0,5 \times$ **maximum allowable pressure**; and
- $1,0 \times$ **maximum allowable pressure**.

The test shall be performed with refrigerant vapour or other gases with known property.

Equivalent tests, for example an air or a helium leakage test, are permitted, provided it is documented that the tightness test achieves at least the same performance as the test with refrigerant vapour.

The **safety shut-off valves** shall be marked with information for the identification of the valve in case of replacement:

- means for identification of the **safety shut-off valves** for facilitating correct replacement, and
- arrow indicating the direction of flow, when applicable.

Compliance is checked by inspection.

The closing of **safety shut-off valves** in liquid refrigerant lines shall not result in pressures exceeding the **maximum allowable pressure**.

NOTE 5 The purpose is to prevent excessive pressures due to hydraulic shock or trapped liquid refrigerant that could expand when temperature changes.

*Compliance is tested by measuring the pressure before and after the valve with a fast response pressure sensor with a time resolution not greater than 0,1 s while opening and closing the valve at the highest liquid refrigerant velocity during **normal operation**.*

22.133 Particle foam material shall not be used outdoors without protective cover of metal or rigid plastic material if the appliance is accessible to the general public.

Compliance is checked by inspection and measurement.

22.134 Appliances shall be constructed so that **particle foam material** expanded polypropylene is separated from metallic parts containing cobalt, manganese or copper if operating at a temperature higher than 80 °C.

NOTE Direct contact of expanded polypropylene foam material (material marking according to ISO 1043-1: PP-E) with cobalt, manganese or copper causes degradation of the expanded polypropylene foam material at temperatures above 80 °C.

However, this requirement is not applicable for **particle foam material** parts when a deterioration of 3 mm at the contact point will not cause the appliance to fail to comply with this standard. If the separation is provided by an air gap, it shall be at least 3 mm.

Compliance is checked by inspection and measurement.

22.135 Double wall heat exchangers for refrigerating systems employing **flammable refrigerants** with **refrigerant charge** $m_c > m_1$ shall be constructed and connected in a way that they do not allow refrigerants to leak into the secondary circuit if one of the walls breaks.

The intermediate chamber shall be one of the following:

- a) vented to the outdoors;
- b) vented into a room that has equal or larger room area than the required minimum room area determined in Annex GG;
- c) for closed intermediate chamber, monitored to recognize that one of the walls is broken, and if recognize the compressor shall stop.

NOTE This monitoring can be performed by detecting the pressure in the intermediate chamber.

Compliance is checked by inspection for a) and b). For c) the following tests shall be performed

- *by applying the minimum and maximum secondary circuit pressure to the intermediate chamber. The compressor shall stop within 1 min;*
- *by applying the minimum and maximum refrigerant condensing pressure to the intermediate chamber. The compressor shall stop within 1 min.*

23 Internal wiring

This clause of Part 1 is applicable except as follows.

23.101 Wires shall be protected if they can be damaged by contact with refrigerant piping.

NOTE Refrigerant piping can destroy the cable insulation by relative movement between the pipe and the wire due to vibrations, even when the vibrations are not severe.

Compliance is checked by inspection.

24 Components

This clause of Part 1 is applicable except as follows.

24.1 Addition:

Motor-compressors shall:

- comply with IEC 60335-2-34 (including its Annex AA), or
- comply with IEC 60335-2-34 (without Annex AA) and comply with Clause 11 of this standard, or

NOTE 101 The motor-compressor includes its motor-compressor protection and control system used for compliance with IEC 60335-2-34.

- comply with this standard and in addition shall comply with IEC 60335-2-34:2021, 22.9.

24.1.4 Modification:

– self-resetting thermal cut-outs	3 000
– other non-self-resetting thermal cut-outs	300

Addition:

– thermostats which control the motor-compressor	100 000
– motor-compressor starting relays	100 000
– automatic thermal motor-protectors for motor-compressors of the hermetic and semi-hermetic type	min. 2 000 (but not less than the number of operations during the locked rotor test)
– manual reset thermal motor-protectors for motor-compressors of the hermetic and semi-hermetic type	50
– other automatic thermal motor protectors	2 000
– other manual reset thermal motor protectors	30
– refrigerant detection systems self-resetting	300
– refrigerant detection systems non-self-resetting	30

–	<i>electromechanical proof of airflow control</i>	100 000
–	<i>self-resetting electrical pressure-limiting device</i>	3 000
–	<i>non-self-resetting electrical pressure-limiting device</i>	300

24.101 Thermal control devices incorporating replaceable parts shall be marked in such a way that the replaceable parts can be identified.

The replacement part shall be marked accordingly.

Compliance is checked by inspection of the marking.

24.102 The **pressure-limiting devices** used in **transcritical refrigerating systems** shall comply with IEC 60730-2-6 and

- shall be of type 2.A or 2.B;
- shall have a trip free mechanism of type 2.J;
- the deviation and drift shall not exceed + 0 %.

Compliance is checked by inspection.

25 Supply connection and external flexible cords

This clause of Part 1 is applicable except as follows.

25.1 Addition:

Appliances may be provided with a **supply cord** fitted with a plug

- if the **supply cord** with a plug is for indoor use only,
- if they have a marked rating of 25 A or less, and
- if they comply with the applicable code requirements for cord-connected appliances appropriate to the specific country in which they are to be used.

Modification:

Appliances shall not be provided with an appliance inlet.

25.7 Addition:

Supply cords of parts of appliances for outdoor use shall not be lighter than polychloroprene sheathed flexible cord (code designation 60245 IEC 57).

26 Terminals for external conductors

This clause of Part 1 is applicable.

27 Provision for earthing

This clause of Part 1 is applicable except as follows.

27.5 Addition:

NOTE 101 If the ground continuity between system components meets the maximum values specified in 27.5, it is considered to meet the requirements without dedicated grounding conductors.

28 Screws and connections

This clause of Part 1 is applicable.

29 Clearances, creepage distances and solid insulation

This clause of Part 1 is applicable except as follows.

Addition:

Compliance is not checked on parts relating to motor-compressors if the motor-compressor complies with IEC 60335-2-34. For motor-compressors not complying with IEC 60335-2-34, the additions and modifications specified in IEC 60335-2-34:2021, Clause 29, are applicable.

29.2 Addition:

For insulation located in any airflow, the micro-environment is pollution degree 3 unless the insulation is enclosed or located so that it is unlikely to be exposed to pollution due to normal use of the appliance.

30 Resistance to heat and fire

This clause of Part 1 is applicable except as follows.

30.1 Modification:

Add the following to the first paragraph of the test specification:

*However, for external parts of **particle foam material** made of*

- *expanded polypropylene (EPP), or*
- *expanded polystyrene (EPS)*

*which are not supporting **live parts** and are at least 8 mm thick and have a density equal to or more than 55 kg/m³ and less than or equal to 250 kg/m³ compliance is checked by the test of 30.101.*

NOTE 101 Measurement of density can be made according to ISO 845.

30.2.2 Not applicable.

30.101 The ball pressure test for **particle foam material** is carried out using the apparatus specified in IEC 60695-10-2:2014, Clause 5, using the loading device shown in Figure 1a with additional dimensions and shape as shown in Figure 105.

The size of test specimen shall be at least 60 mm × 60 mm.

The weight shall be applied to the outer surface of the part, and not to a cut-away exposing an interior substrate for the purposes of sample preparation.

The test specimen shall be stored for at least 24 h before the test in an atmosphere having a temperature between 15 °C and 35 °C and a relative humidity between 45 % and 75 %.

Place the test specimen in the approximate centre of the test specimen support ensuring that its upper surface is horizontal. Gently lower the pressure ball of the loading device on to the approximate centre of the test specimen. Ensure that no conditions exist that will cause the pressure ball to move other than in a downward direction during the test.

The installation of the test specimen and application of the weight shall be performed within 30 s. The test chamber shall return to the specified temperature (± 2 °C) within 5 min and without any overshoot exceeding 5 °C.

The test specimen with the loading device shall remain for a period of 60^{+2}_{-0} min in the test chamber.

The thickness of the sample at the point of contact with the loading device shall be measured before and immediately after the conditioning in the chamber according to Figure 106.

The test shall be performed at a temperature (40 ± 2) K above the maximum temperature rise measured at accessible surface during the test in Clause 11, but not less than 75 °C.

NOTE There can be a big difference between the internal and external surface of thermal isolation.

However, for parts providing **supplementary insulation** or **reinforced insulation**, the test shall be performed at a temperature, which is (25 ± 2) K above the maximum temperature rise measured during the test in Clause 19, if this is higher. The temperature rises of Clause 19 are not considered, provided the tests of Clause 19 are terminated by a **non-self-resetting protective device**. The resetting of the **non-self-resetting protective device** shall require removal of a cover or the using of a **tool**.

After the test, the thickness of the material shall be no less than 50 % of the original material thickness but not less than 4 mm.

31 Resistance to rusting

This clause of Part 1 is applicable except as follows.

Addition:

Compliance is checked by the salt mist test of IEC 60068-2-52, severity 2 being applicable.

Before the test, coatings are scratched by means of a hardened steel pin, the end of which has the form of a cone with an angle of 40°. Its tip is rounded with a radius of $0,25 \text{ mm} \pm 0,02 \text{ mm}$. The pin is loaded so that the force exerted along its axis is $10 \text{ N} \pm 0,5 \text{ N}$. The scratches are made by drawing the pin along the surface of the coating at a speed of approximately 20 mm/s. Five scratches are made at least 5 mm apart and at least 5 mm from the edges.

After the test, the appliance shall not have deteriorated to such an extent that compliance with this standard is impaired. The coating shall not be broken and shall not have loosened from the metal surface.

NOTE 101 This test can in particular affect compliance with Clause 8 and Clause 27.

32 Radiation, toxicity and similar hazards

This clause of Part 1 is applicable except as follows.

32.101 For UV-C irradiance test:

32.101.1 For the occupied space outside the unit, a test shall be performed to determine the **UV-C spectral irradiance**. The emissions from the equipment shall not exceed a **UV-C spectral irradiance** limit of $0,2 \mu\text{W}/\text{cm}^2$.

NOTE The **UV-C spectral irradiance** limit of $0,2 \mu\text{W}/\text{cm}^2$ is equivalent to $0,1 \mu\text{W}/\text{cm}^2$ effective irradiance at 254 nm (i.e., $0,2 \mu\text{W}/\text{cm}^2$ multiplied by the hazard function, $S_{\text{UV}} = 0,5$ at 254 nm as defined in IEC 62471 equals $0,1 \mu\text{W}/\text{cm}^2$). Effective irradiance of $0,1 \mu\text{W}/\text{cm}^2$ is classified as exempt in IEC 62471.

32.101.2 For areas inside the unit that are accessible for anticipated **user maintenance** and are not equipped with the interlock required by 22.128, there shall be no **UV-C spectral irradiance** greater than $1,7 \mu\text{W}/\text{cm}^2$. The **UV-C spectral irradiance** is measured at any point of accessibility required for **user maintenance**. When determining user accessibility, consideration should be given to the maximum exposure time of 60 min/day at $1,7 \mu\text{W}/\text{cm}^2$ spectral irradiance, that the user would experience in performing their duties.

NOTE The **UV-C spectral irradiance** limit of $1,7 \mu\text{W}/\text{cm}^2$ is equivalent to $0,85 \mu\text{W}/\text{cm}^2$ effective irradiance at 254 nm (i.e., $1,7 \mu\text{W}/\text{cm}^2$ multiplied by the hazard function, $S_{\text{UV}} = 0,5$ at 254 nm as defined in IEC 62471 equals $0,85 \mu\text{W}/\text{cm}^2$).

*Compliance is determined by measuring the **UV-C spectral irradiance** in accordance with IEC 62471:2006, Clause 5 and Annex B.*

32.101.3 **UV-C spectral irradiance** shall be measured at the location indicated in Table 102.

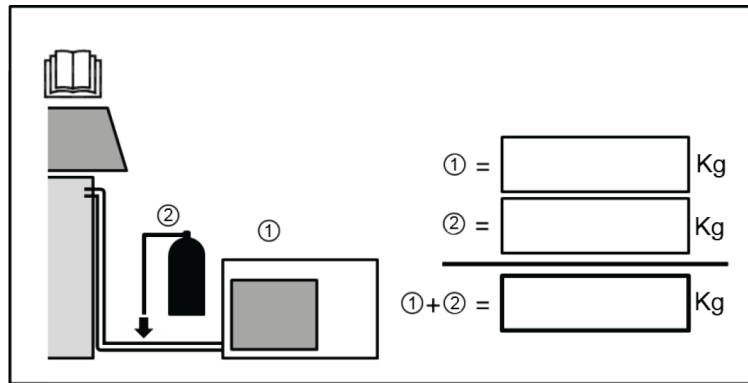
Table 102 – UV-C spectral irradiance measurement location

	UV-C spectral irradiance limits		For compliance, UV-C spectral irradiance is measured
	$\mu\text{W}/\text{cm}^2$	W/m^2	
Occupied space outside unit	$\leq 0,2^a$	$\leq 0,002$	At 0,3 m from all outside surfaces of appliance ^c
Supply and return air openings	$\leq 0,2^a$	$\leq 0,002$	At 0,3 m from the perpendicular plane of the opening
User maintenance openings ^b	$\leq 1,7$	$\leq 0,017$	At 0,3 m from the perpendicular plane of the access opening
UV-C lamp replacement			Not required – all power shall be disconnected
^a Less than or equal to $0,1 \mu\text{W}/\text{cm}^2$ effective irradiance is exempt according to IEC 62471. This is $0,2 \mu\text{W}/\text{cm}^2$ spectral irradiance at 254 nm. ^b Based on maximum exposure time of 60 min/day. ^c If the appliance has an inspection window, the measuring distance is reduced to 0,0 m.			

32.101.4 When conducting **UV-C spectral irradiance** tests

- the **UV-C spectral irradiance** measurements shall be conducted with a scanning spectroradiometer, or a narrow band range radiometer;
- all panels and components shall be positioned or adjusted in the most severe position;
- removable air filters shall be removed;
- measurements shall be made at the worst case location and angle of incidence;

- the minimum specified duct and configuration, including any duct liners, specified by the manufacturer shall be in place and the measurements taken at the opening at the end of the duct.

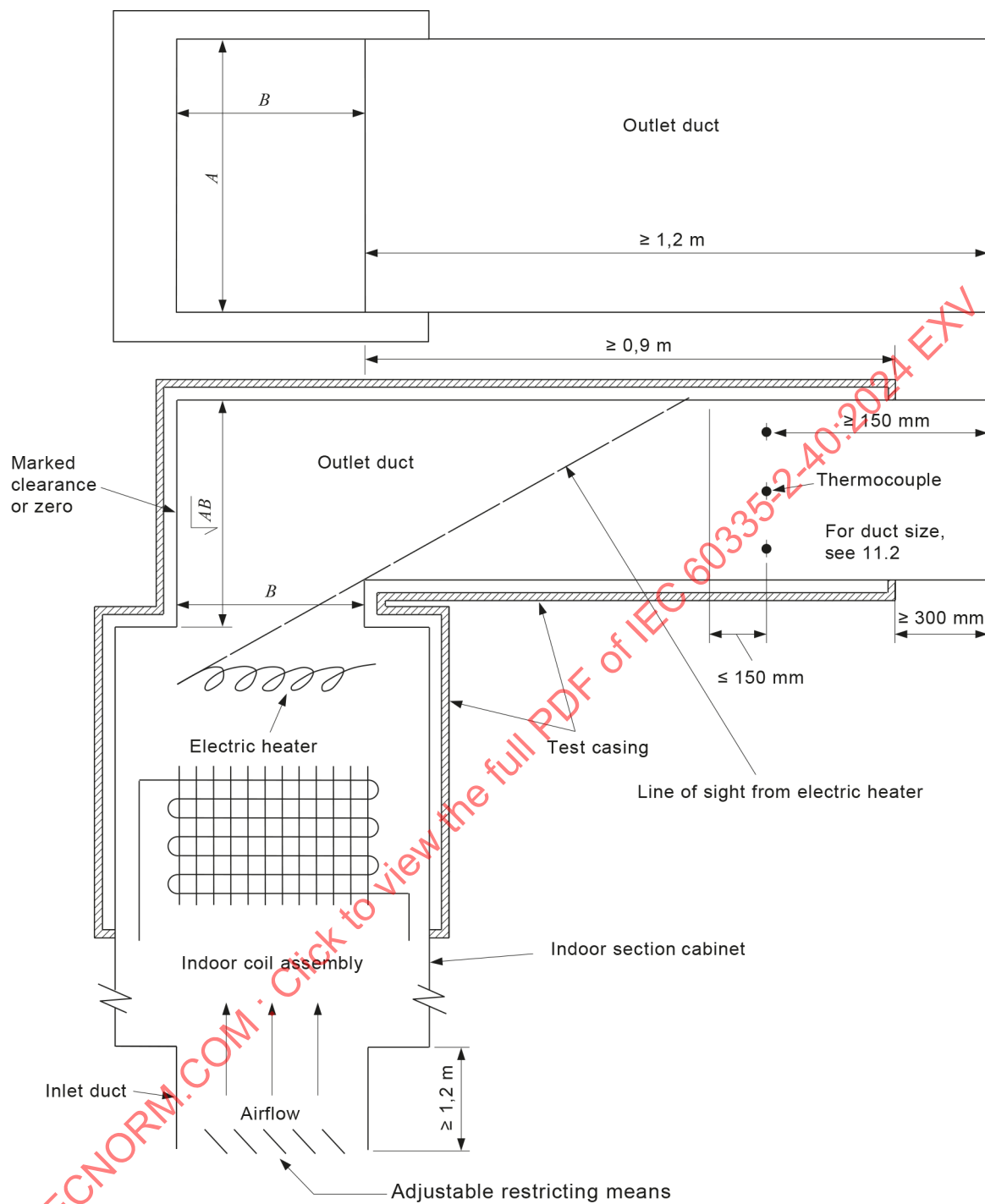


Key

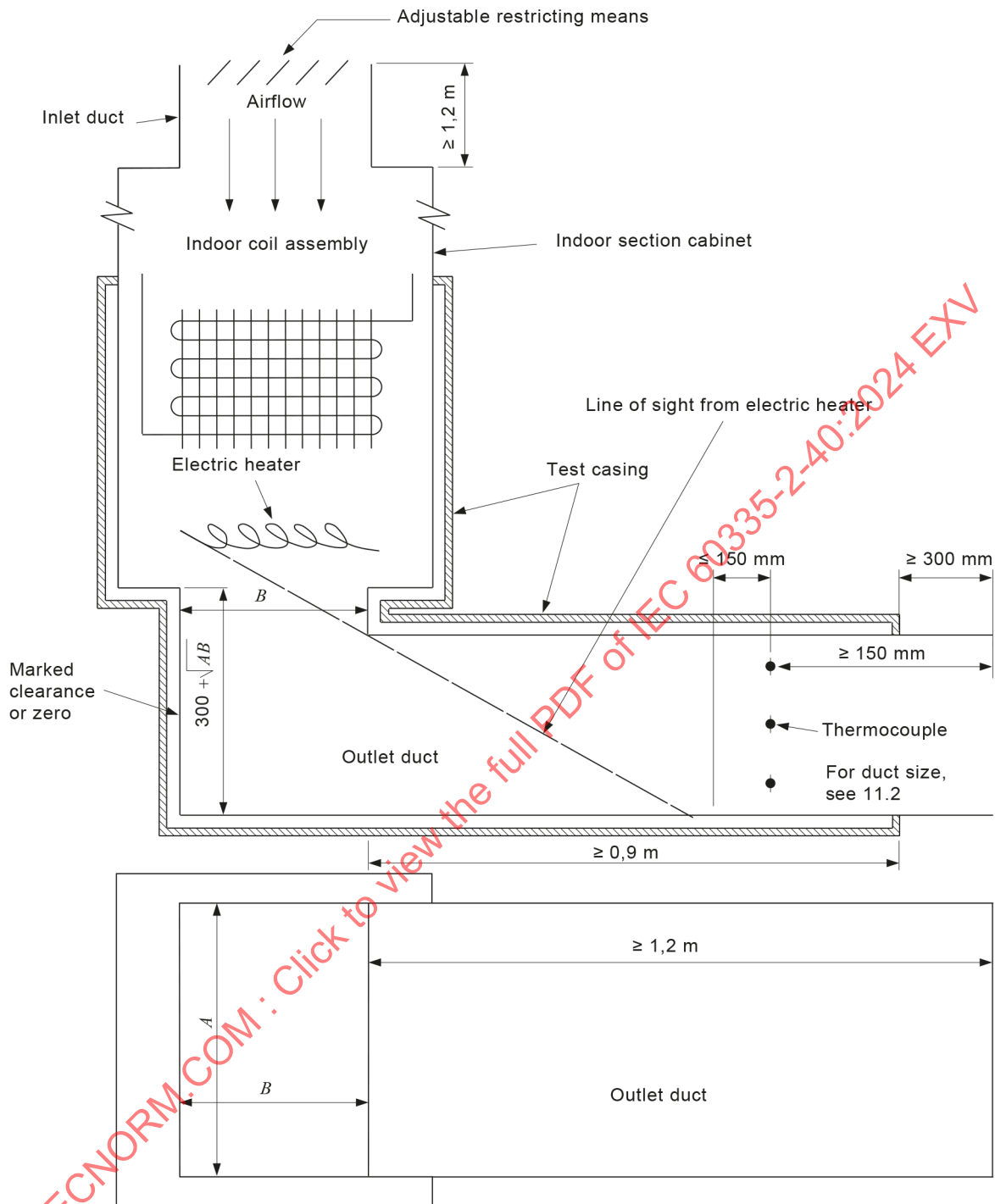
Example 1 **refrigerant charge** of the precharged part of the appliance

Example 2 **refrigerant charge** added during installation

Figure 101 – Example of label for field charged units



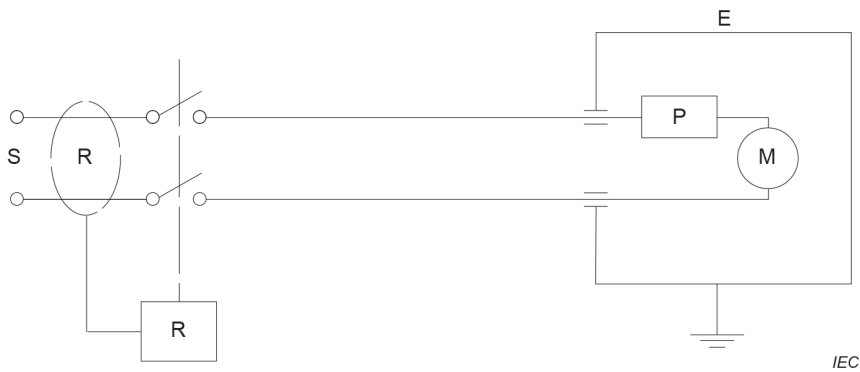
a) Upflow application



IEC

b) Downflow application

Figure 102 – Arrangement for heating test of appliances with supplementary air heater



Key

- S supply
- E motor enclosure
- R residual current device ($I_{\Delta n} = 30 \text{ mA}$) (RCCB or RCBO)
- P **protective device** (external or internal)
- M motor

NOTE The figure can be revised as necessary for three-phase test.

Figure 103 – Supply circuit for locked-rotor test of a motor of the single-phase type

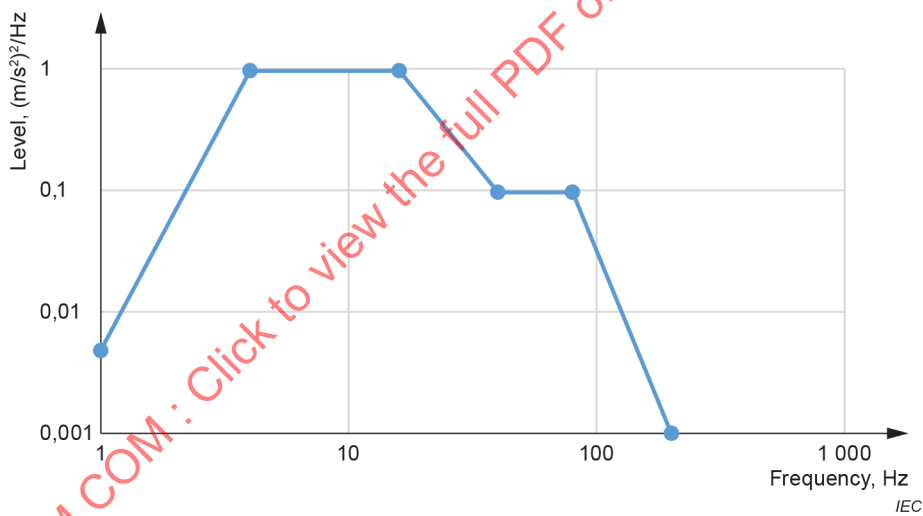


Figure 104 – Power spectral density profile for vibration test in 21.101

Dimensions in millimetres

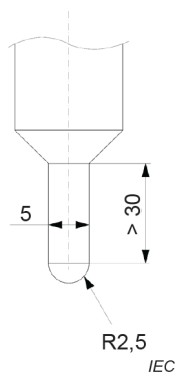
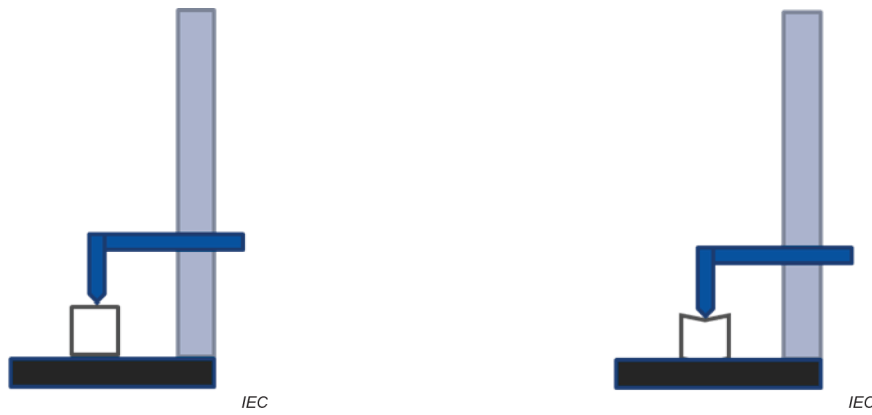


Figure 105 – Dimensional details for the weight in the area of the pressure ball



a) Measurement 1: Height specimen unloaded

b) Measurement 2: Height specimen after loading

Figure 106 – Measurement before and after the test

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annexes

The annexes of Part 1 are applicable except as follows.

Annex D (normative)

Thermal motor protectors

This annex of Part 1 is not applicable.

Annex I (normative)

Motors having basic insulation that is inadequate for the rated voltage of the appliance

This annex of Part 1 is not applicable.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Function of appliance	Classification		Heating				Cooling			
			Outdoor assembly °C (inlet)		Indoor assembly °C (outlet)		Outdoor assembly °C (inlet)		Indoor assembly °C (outlet)	
			DB ^a	WB ^b	DB ^a	WB ^b	DB ^a	WB ^b	DB ^a	WB ^b
Outside air/ Recycled air	A7	A20	7	6	20	12	35	24	27	19
Exhaust air/ Recycled air	A20	A20	20	12	20	12	–	–	–	–
Exhaust air/ Fresh air	A20	A7	20	12	7	6	–	–	–	–
Outside air/Water	A7	W50	7	6	Water	50	35	24	Water	7
Exhaust air/Water	A20	W50	20	12	Water	50	–	–	–	–
Water/Water	W10	W50	Water	10	Water	50	Water	15	Water	7
Brine/Water	B0	W50	Brine	0	Water	50	Brine	15	Water	7
Brine/Recycled air	B0	A20	Brine	0	20	12	–	–	–	–
Water/Recycled air	W10	A20	Water	10	20	12	–	–	–	–
Water/Recycled air	W20	A20	Water	20	20	12	–	–	–	–
Dehumidification	Comfort Process Heat recovery (air cooled) Heat recovery (water cooled)		–	–					27 12 27 27	21 9 21 21
Sanitary hot water heat pump										
Outside air/Water	A7	W45	7	6	Water	45	–	–	–	–
Ambient air/Water	A15	W45	15	12	Water	45	–	–	–	–
Exhaust air/Water	A20	W45	20	12	Water	45	–	–	–	–
Brine/Water	B0	W45	Brine	0	Water	45	–	–	–	–

NOTE Appliance can be classified according to function and temperature application as noted below:

Source	Outside air	Sink	Recycled air	Classification	A –	A *
Exhaust air		Recycled air		A –	A –	
Exhaust air		Outside air		A –	A –	
Outside air		Water		A –	W –	
Exhaust air		Water		A –	W –	
Water		Water		W –	W –	
Water		Recycled air		W –	A –	
Brine		Recycled air		B –	A –	
Brine		Water		B –	W –	

* For example, A7 A20 indicates an appliance designed for an outside air operating temperature of 7 °C DB and an inside air operating temperature of 20 °C DB.

^a **DB: dry bulb temperature**

^b **WB: wet bulb temperature**

Annex BB
(normative)

Selected information about refrigerants

Table BB.1 gives selected information about refrigerants.

Table BB.1 – Selected information about refrigerants

NOTE Annex BB is not a complete list of suitable refrigerants. This standard applies to any refrigerants as defined in the scope.

Refrigerant designation a	Description	Formula (nominal composition mass fraction %)	Safety group f	Auto ignition temperature	Hot surface ignition temperature g	Maximum allowable surface temperature g	Density b	Molar mass at nominal composition h	Molar mass at worst case formulation i	Lower flammability limit b,d at nominal composition h	Lower flammability limit b,d at worst case formulation i	Burning velocity, $S_{u,r}$ at 23 °C 50 % relative humidity at nominal composition	Burning velocity, $S_{u,r}$ at 27 °C dew point at nominal composition
R32	Difluoromethane	CH_2F_2	A2L	648	> 800 (A2L only)	700	2,13	52,0	NA	0,306	NA	6,7	6,7
R50	Methane	CH_4	A3	645	NA	645	0,65	16,0	NA	0,032	NA		
R143a	1,1,1-Trifluoroethane	CF_3CH_3	A2L	750	ND	750	3,43	84,0	NA	0,282	NA		
R152a	1,1-Difluoroethane	CHF_2CH_3	A2	455	NA	455	2,70	66,0	NA	0,130	NA		
R170	Ethane	CH_3CH_3	A3	515	NA	515	1,23	30,1	NA	0,038	NA		
R290	Propane	$\text{CH}_3\text{CH}_2\text{CH}_3$	A3	470	NA	470	1,80	44,1	NA	0,038	NA		
R600	n-Butane	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$	A3	365	NA	365	2,37	58,1	NA	0,038	NA		
R600a	Isobutane	$\text{CH}(\text{CH}_3)_3$	A3	460	NA	460	2,37	58,1	NA	0,043	NA		
R1150	Ethylene	$\text{CH}_2=\text{CH}_2$	A3	425	NA	ND	1,15	28,1	NA	0,036	NA		

Refrigerant designation a	Description	Formula (nominal composition mass fraction %)	Safety group f	Auto ignition temperature	Hot surface ignition temperature g	Maximum allowable surface temperature g	Density b	Molar mass c at nominal composition h	Molar mass c at worst case formulation i	Lower flammability limit b,d at nominal composition h	Lower flammability limit b,d at worst case formulation i	Burning velocity, $S_{u'}$ at 23 °C 50 % relative humidity at nominal composition	Burning velocity, $S_{u'}$ at 27 °C dew point at nominal composition
				°C	°C (A2L only)	°C	kg/m ³	kg/kmol	kg/kmol	kg/m ³	kg/m ³	cm/s	cm/s
R1132	1,1-difluoroethylene	CF ₂ =CH ₂	A2	ND	NA	ND	2,61	64,0	NA	0,131	NA		
R1270	Propylene	CH ₂ =CHCH ₃	A3	455	NA	455	1,72	42,1	NA	0,046	NA		
RE170	Dimethylether	(CH ₃) ₂ O	A3	235	NA	235	1,88	46,1	NA	0,064	NA		
R142b	1-chloro-1,1-difluoroethane	CH ₃ CClF ₂	A2L	750 ^e	ND	750	4,11	100,5	NA	0,329	NA		
R1234yf	2,3,3,3-tetrafluoro-1-propene	CF ₃ CF=CH ₂	A2L	405	> 800	700	4,66	114,0	NA	0,289	NA		
R1234ze(E)	Trans-1,3,3,3-tetrafluoro-1-propene	CF ₃ CF=CHF	A2L	368	> 800	700	4,66	114,0	NA	0,303	NA		
R-444A	R-32/152a/1234ze (E)	(12,0/5,0/83,0)	A2L	ND	> 800	700	4,03	96,7	95,2	0,324	0,319		
R-444B	R-32/152a/1234ze (E)	(41,5/10,0/48,5)	A2L	ND	> 800	700	3,02	72,8	73,0	0,277	0,276		
R-445A	R-744/134a/1234ze (E)	(6,0/9,0/85,0)	A2L	ND	ND	ND	4,29	103,1	104,7	0,341	0,347		
R-446A	R-32/1234ze(E)/600	(68,0/29,0/3,0)	A2L	ND	ND	ND	2,60	62,0	62,4	0,236	0,237		
R-447A	R-32/125/1234ze(E)	(68,0/3,5/28,5)	A2L	ND	ND	ND	2,61	63,0	63,1	0,304	0,331		
R-447B	R-32/125/1234ze (E)	(68,0/8,0/24,0)	A2L	ND	> 800	700	2,58	63,1	63,1	0,312	0,312		
R-451A	R-1234yf/134a	(89,8/10,2)	A2L	ND	> 800	700	4,71	112,7	112,7	0,322	0,341		
R-451B	R-1234yf/134a	(88,8/11,2)	A2L	ND	> 800	700	4,70	112,6	112,6	0,322	0,341		

Refrigerant designation a	Description	Formula (nominal composition mass fraction %)	Safety group f	Auto ignition temperature	Hot surface ignition temperature g	Maximum allowable surface temperature g	Density b	Molar mass c at nominal composition h	Molar mass c at worst case formulation i	Lower flammability limit b,d at nominal composition h	Lower flammability limit b,d at worst case formulation i	Burning velocity, $S_{u'}$ at 23 °C 50 % relative humidity at nominal composition	Burning velocity, $S_{u'}$ at 27 °C dew point at nominal composition
				°C	°C (A2L only)	°C	kg/m ³	kg/kmol	kg/kmol	kg/m ³	kg/m ³	cm/s	cm/s
R-452B	R-32/125/1234yf	(67,0/7,0/26,0)	A2L	509	> 800	700	2,63	63,5	63,5	0,309	0,310	< 4,0	
R-454A	R-32/1234yf	(35,0/65,0)	A2L	457	> 800	700	3,34	80,5	81,8	0,273	0,281	< 4,0	
R-454B	R-32/1234yf	(68,9/31,1)	A2L	496	> 800	700	2,59	62,6	63,0	0,307	0,296	5,7	
R-454C	R-32/1234yf	(21,5/78,5)	A2L	444	> 800	700	3,78	90,8	92,5	0,286	0,291	< 4,0	
R-455A	R-744/32/1234yf	(3,0/21,5/75,5)	A2L	ND	> 800	700	3,64	87,5	89,4	0,422	0,431		
R-457A	R-32/1234yf/152a	(18,0/70,0/12,0)	A2L	ND	ND	ND	3,65	87,6	88,0	0,215	0,216		
R-459A	R-32/1234yf/1234ze(E)	(68,0/26,0/6,0)	A2L	ND	ND	ND	2,61	63,0	63,6	0,276	0,279		
R-459B	R-32/1234yf/1234ze(E)	(21,0/69,0/10,0)	A2L	ND	ND	ND	3,79	91,2	92,1	0,369	0,373		
R-462A	R-32/125/143a/134a/600	(9,0/42,0/2,0/44,0/3,0)	A2L	ND	ND	ND	4,04	91,1	67,8	0,230	0,291		

Refrigerant designation a	Description	Formula (nominal composition mass fraction %)	Safety group f	Auto ignition temperature	Hot surface ignition temperature g	Maximum allowable surface temperature g	Density b	Molar mass c at nominal composition h	Molar mass c at worst case formulation i	Lower flammability limit b,d at nominal composition h	Lower flammability limit b,d at worst case formulation i	Burning velocity, $S_{u'}$ at 23 °C relative humidity at nominal composition	Burning velocity, $S_{u'}$ at 27 °C dew point at nominal composition
R-465A	R-32/290/1234yf	(21,0/7,9/71,1)	A2L	°C ND	°C (A2L only) ND	°C ND	kg/m ³ 3,45	kg/kmol 82,9	kg/kmol 83,6	kg/m ³ 0,159	kg/m ³ 0,161	cm/s	cm/s

If any data in this table is missing or in conflict with the data in ISO 817, then the value in ISO 817 shall take precedence. Where the **LFL** at nominal composition is not given, the **LFL** at worst case formulation shall be used.

The tables with ISO 817 refrigerant data are provided at <https://standards.iso.org/iso/817/ma/en/>.

ND means non-determined. Consult the safety data sheet of the manufacturer.

NA means not applicable.

a The refrigerant designations are in accordance with ISO 817.

b These values are at 25 °C and at 1 013,2 mbar.

c For comparison, the molecular mass of air is taken equal to 28,8 kg/kmol.

d Multiply % v/v by the corresponding molar mass × 0,000 409 to give the flammability limit in kg/m³.

e Estimated from molecular structure.

f Safety group of refrigerants based upon ISO 817.

g For **flammable refrigerants**, the maximum allowable surface temperature is determined by **AIT**.
For **A2L refrigerants**, the maximum allowable surface temperature is determined by the highest of **AIT** or, if tested per Annex KK, the **hot surface ignition temperature** reduced by 100 K.

h Nominal composition means design composition as stated in the refrigerant blend application, excluding any tolerances.

i Worst case formulation means the composition that results from application of the tolerances to the nominal composition resulting in the most toxic or most flammable formulation.

Annex CC (informative)

Transportation, marking and storage for units that employ flammable refrigerants

CC.1 General

The following information is provided for units that employ **flammable refrigerants**.

CC.2 Transport of equipment containing flammable refrigerants

Attention is drawn to the fact that additional transportation regulations can exist with respect to equipment containing flammable gas. The maximum number of pieces of equipment or the configuration of the equipment permitted to be transported together will be determined by the applicable transport regulations.

CC.3 Marking of equipment using signs

Signs for similar appliances used in a work area are generally addressed by local regulations and give the minimum requirements for the provision of safety and/or health signs for a work location.

All required signs are to be maintained and employers should ensure that employees receive suitable and sufficient instruction and training on the meaning of appropriate safety signs and the actions that should be taken in connection with these signs.

The effectiveness of signs should not be diminished by too many signs being placed together.

Any pictograms used should be as simple as possible and contain only essential details.

CC.4 Disposal of equipment using flammable refrigerants

See national regulations.

CC.5 Storage of equipment/appliances

The storage of the appliance should be in accordance with the applicable regulations or instructions, whichever is more stringent.

CC.6 Storage of packed (unsold) equipment

Storage package protection should be constructed in such a way that mechanical damage to the equipment inside the package will not cause a leak of the **refrigerant charge**.

The maximum number of pieces of equipment permitted to be stored together will be determined by local regulations.

Annex DD (normative)

Requirements for installation, service, maintenance and repair, and decommissioning instructions of appliances using flammable refrigerants

DD.1 General

Each of the instructions shall include requirements of clauses according to Table DD.1. Different instructions can be combined into one document.

Numerical values necessary for proper installation, service, maintenance and repair, and decommissioning shall be in the form of a single figure or a table without reference to a formula.

For **factory sealed single package units**, it is not necessary for the installation instructions to include material from DD.4.8 and Clause DD.9.

Table DD.1 – Mandatory clauses in each of the instructions

Clause/subclause	Installation	Service, maintenance and repair	Decommissioning	Note
DD.2	Yes	Yes	Yes	
DD.3.1	Yes	Yes	No	
DD.3.2	Yes	Yes	No	User instructions also
DD.3.3	Yes	Yes	Yes	
DD.4	No	Yes	Yes	
DD.4.1	No	Yes	Yes	
DD.4.2	No	Yes	Yes	
DD.4.3	No	Yes	Yes	
DD.4.4	No	Yes	Yes	
DD.4.5	No	Yes	Yes	
DD.4.6	No	Yes	Yes	
DD.4.7	No	Yes	Yes	
DD.4.8	Yes	Yes	No	
DD.4.9	No	Yes	No	
DD.5	No	Yes	No	
DD.6	Yes	Yes	No	
DD.7	Yes	Yes	Yes	
DD.8	No	Yes	Yes	
DD.9	Yes	Yes	No	
DD.10	No	No	Yes	
DD.11	No	No	Yes	
DD.12	No	Yes	Yes	

DD.2 Symbols

The symbols referred to in 7.6 (without colours is permitted) and the information of the warning marking shall be provided as follows:

WARNING

Do not use means to accelerate the defrosting process or to clean, other than those recommended by the manufacturer.

The appliance shall be stored in a room without continuously operating ignition sources (for example: open flames, an operating gas appliance or an operating electric heater).

Do not pierce or burn.

Be aware that refrigerants might not contain an odour.

The manufacturer may provide other suitable examples or may provide additional information about the refrigerant odour.

DD.3 Information in instructions

DD.3.1 General

The following information shall be specified in the instructions where the information is necessary for the function of the instructions and as applicable to the appliance:

- 1) information for spaces where field-installed refrigerant pipes are allowed, including statements
 - a) that the installation of pipe-work shall be kept to a minimum;
 - b) that pipe-work shall be securely mounted and guarded from physical damage;
 - c) that pipe-work shall not be installed in an unventilated space, if that space is smaller than $A_{\min}$ in Annex GG, except for A2L refrigerants where installed pipe-work has no connecting joints or is connected with at least one of the following:
 - i) joints in compliance with ISO 14903,
 - ii) joints in enclosures which vent to the unit or to the outside,
 - iii) joints in enclosures which vent to a room with a room area of at least $A_{\min}$ as specified in GG.2.1;
 - d) that national gas regulations can impose additional requirements;
 - e) that mechanical connections made in accordance with 22.118 shall be accessible for maintenance purposes;
- 2) where addition of charge is required to complete installation, instructions on how to determine the additional **refrigerant charge** and how to complete the **refrigerant charge** on the label provided by the manufacturer considering the requirements in 7.107. Interconnecting refrigerant piping length and diameter shall be taken into consideration;
- 3) where **safety shut-off valves** are installed, instructions on how to determine the **releasable charge**, m_{r1} . **Safety shut-off valve** location and refrigerant piping volume between **safety shut-off valve** and the indoor unit shall be taken into consideration;

- 4) detailed instructions on how to correctly install the appliance including piping and safety shut-off valves for every space in which refrigerant can leak into, where applicable:
 - a) minimum room area, $A_{\min}$, or minimum room area of conditioned space $TA_{\min}$, as a function of the **refrigerant charge**, m_c , or as a function of the **releasable charge**, m_{rl} . If the **releasable charge**, m_{rl} , has been used, a warning that the minimum room area or minimum room area of conditioned space is based on **releasable charge** and is not related to total system **refrigerant charge**;
 - b) **refrigerant charge**, m_c , and, if the **releasable charge**, m_{rl} , has been determined, the **releasable charge**, m_{rl} . The effect on **refrigerant charge** shall be considered from field-installed piping, field charging, or both, if applicable;
 - c) required **installed height**, h_{inst} ;
 - d) minimum ventilation airflow volume $Q_{\min}$;
 - e) minimum opening area for natural ventilation $A_{\text{nv},\min}$.

Additional minimum room area data may be provided based on other **installed heights** and/or charge levels;

- 5) information for handling, installation, cleaning, servicing and disposal;
- 6) for appliances intended for use at altitudes 2 000 m and above, the instructions shall include how to adjust minimum room area, $A_{\min}$, and minimum room area of conditioned space, $TA_{\min}$, as applicable from Annex GG, based on the building site ground level altitude;
- 7) a warning to keep any required ventilation openings clear of obstruction;
- 8) a notice that servicing shall be performed only as recommended by the manufacturer;
- 9) a warning that ducts connected to an appliance shall not contain a potential ignition source;
- 10) instructions for wiring to external zoning dampers and/or mechanical ventilation, if required to comply with Clause GG.9, to ensure that upon detection of a leak, the zoning dampers are driven fully open and additional mechanical ventilation is activated;
- 11) for mechanical ventilation as specified in GG.8.3 or for **enhanced tightness refrigerating systems** in GG.11.3, information on installation of the mechanical ventilation air extracted and air intake openings per GG.8.3.3 or for **enhanced tightness refrigerating systems** in GG.11.3.3;
- 12) for appliances relying on safety measures according to GG.8.3 or for **enhanced tightness refrigerating systems** according to GG.11.3, instructions for wiring to mechanical ventilation;
- 13) for appliances using a remote located **refrigerant sensor**, how and where to install and connect the **refrigerant sensor** in compliance with the requirements of 22.121.1, including how to verify correct installation by test;
- 14) when a remote located **refrigerant sensor** is specified by the manufacturer, the instructions shall state the recommended periodic service and maintenance procedures;
- 15) when a **limited life refrigerant sensor** is employed, the life of the **refrigerant sensor** and instruction on how to replace it;
- 16) for appliances using **A2L refrigerants**, connected via an air duct system to one or more rooms, the supply and return air shall be directly ducted to the space. Open areas such as false ceilings shall not be used as a return air duct;
- 17) a warning that precautions shall be taken to avoid excessive vibration or pulsation to refrigerating piping;
- 18) a warning that protection devices, piping and fittings shall be protected as far as possible against adverse environmental effects, for example the danger of water collecting and freezing in relief pipes or the accumulation of dirt and debris;
- 19) a warning that provision shall be made for expansion and contraction of long runs of piping;

- 20) a warning that piping in refrigerating systems shall be so designed and installed as to minimize the likelihood of hydraulic shock damaging the system;
- 21) a warning that solenoid valves shall be correctly positioned in the piping to avoid hydraulic shock and shall not block in liquid refrigerant unless adequate relief is provided;
- 22) a warning that steel pipes and components shall be protected against corrosion with a rustproof coating before applying any insulation;
- 23) where field installed **safety shut-off valves** are specified for refrigerating systems, a warning that only **safety shut-off valves** specified by the appliance manufacturer shall be used;
- 24) where **safety shut-off valves** are to be field installed, information on where and how the **safety shut-off valves** shall be installed;
- 25) information that **safety shut-off valves** shall only be replaced with valves specified by the appliance manufacturer;
- 26) field-made refrigerant joints indoors shall be tightness tested. The test method shall have a sensitivity of 5 grams per year of refrigerant or better under a pressure of at least 0,25 times the **maximum allowable pressure**. No leak shall be detected;
- 27) where remote **refrigerant detection systems** are specified, a warning that only **refrigerant sensors** specified by the appliance manufacturer may be used;
- 28) information that the **refrigerant detection system refrigerant sensors** shall only be replaced with **refrigerant sensors** specified by the appliance manufacturer;
- 29) for appliances with a **leak detection system**, **safety shut-off valves** shall not be reset until the room has been ventilated, because resetting can result in additional **flammable refrigerant** released into the space;
- 30) electrical components that can arc or spark, which are not considered ignition sources due to compliance with 22.116.1 points b), c), d), or f) shall only be replaced with parts specified by the appliance manufacturer. Replacement with other parts can result in the ignition of refrigerant in the event of a leak;
- 31) where openings according to GG.1.4 are applied, information that these openings shall not be blocked.

DD.3.2 Unventilated areas

For appliances containing more than m_1 for any refrigerating circuit, the instructions shall include a statement advising that an unventilated area where the appliance is installed shall be so constructed that should any refrigerant leak, it will not stagnate so as to create a fire or explosion hazard. This shall include:

- for appliances which are not **fixed appliances**, a warning that the appliance shall be stored in an area where the room size corresponds to the room area as specified for operation;
- for appliances which are not **fixed appliances**, a warning that the appliance shall be stored in a room without continuously operating open flames (for example an operating gas appliance) or other potential ignition sources (for example an operating electric heater, hot surfaces);
- a warning that if appliances connected via an air duct system to one or more rooms are installed in a room with an area less than $A_{\min}$ as determined in Clause GG.2, that room shall be without continuously operating open flames (for example an operating gas appliance) or other potential ignition sources (for example an operating electric heater, hot surfaces). A flame-producing device may be installed in the same space if the device is provided with an effective flame arrestor;
- for appliances connected via an air duct system to one or more rooms, a warning with the substance of the following: "Auxiliary devices which can be a potential ignition source shall not be installed in the ductwork. Examples of such potential ignition sources are hot surfaces with a temperature exceeding X °C and electric switching devices";

NOTE X is the maximum allowable surface temperature as defined in 22.117.

- for appliances connected via an air duct system to one or more rooms, a warning that only auxiliary devices approved by the appliance manufacturer or declared suitable with the refrigerant shall be installed in the connecting ductwork. The manufacturer can list in the instructions all approved auxiliary devices by the manufacturer and model number for use with the specific appliance.

The manufacturer should specify other potential continuously operating sources known to cause ignition of the refrigerant used.

The appliance shall be stored so as to prevent mechanical damage from occurring.

DD.3.3 Qualification of workers

The instructions shall contain specific information about the required qualification of the working personnel for maintenance, service and repair operations. Every working procedure that affects safety means shall only be carried out by competent persons.

NOTE Information about competence of service personnel is given in informative Annex HH.

Examples for such working procedures are:

- breaking into the refrigerating circuit;
- opening of sealed components;
- opening of ventilated enclosures.

DD.4 Information on servicing

DD.4.1 General

The instructions shall contain specific information for service personnel according to DD.4.2 to DD.4.10.

DD.4.2 Checks to the area

Prior to beginning work on systems containing **flammable refrigerants**, safety checks are necessary to ensure that the risk of ignition is minimised. For repair to the **refrigerating system**, DD.4.3 to DD.4.7 shall be completed prior to conducting work on the system.

DD.4.3 Work procedure

Work shall be undertaken under a controlled procedure so as to minimise the risk of a flammable gas or vapour being present while the work is being performed.

DD.4.4 General work area

All maintenance staff and others working in the local area shall be instructed on the nature of work being carried out. Work in confined spaces shall be avoided.

DD.4.5 Checking for presence of refrigerant

The area shall be checked with an appropriate refrigerant detector prior to and during work, to ensure the technician is aware of potentially toxic or flammable atmospheres. Ensure that the leak detection equipment being used is suitable for use with all applicable refrigerants, i.e. non-sparking, adequately sealed or intrinsically safe.

DD.4.6 Presence of fire extinguisher

If any hot work is to be conducted on the refrigerating equipment or any associated parts, appropriate fire extinguishing equipment shall be available to hand. Have a dry powder or CO₂ fire extinguisher adjacent to the charging area.

DD.4.7 No ignition sources

No person carrying out work in relation to a **refrigerating system** which involves exposing any pipe work shall use any sources of ignition in such a manner that it can lead to the risk of fire or explosion. All possible ignition sources, including cigarette smoking, should be kept sufficiently far away from the site of installation, repairing, removing and disposal, during which refrigerant can possibly be released to the surrounding space. Prior to work taking place, the area around the equipment is to be surveyed to make sure that there are no flammable hazards or ignition risks. "No smoking" signs shall be displayed.

DD.4.8 Ventilated area

Ensure that the area is in the open or that it is adequately ventilated before breaking into the system or conducting any hot work. A degree of ventilation shall continue during the period that the work is carried out. The ventilation should safely disperse any released refrigerant and preferably expel it externally into the atmosphere.

DD.4.9 Checks to the refrigerating equipment

Where electrical components are being changed, they shall be fit for the purpose and to the correct specification. At all times the manufacturer's maintenance and service guidelines shall be followed. If in doubt, consult the manufacturer's technical department for assistance.

*The following checks shall be applied to installations using **flammable refrigerants**:*

- *the **refrigerant charge** is in accordance with the room size within which the refrigerant containing parts are installed;*
- *the ventilation machinery and outlets are operating adequately and are not obstructed;*
- *if an indirect refrigerating circuit is being used, the secondary circuit shall be checked for the presence of refrigerant;*
- *marking to the equipment continues to be visible and legible. Markings and signs that are illegible shall be corrected;*
- *refrigerating pipe or components are installed in a position where they are unlikely to be exposed to any substance which can corrode refrigerant containing components, unless the components are constructed of materials which are inherently resistant to being corroded or are suitably protected against being so corroded.*

DD.4.10 Checks to electrical devices

Repair and maintenance of electrical components shall include initial safety checks and component inspection procedures. If a fault exists that could compromise safety, then no electrical supply shall be connected to the circuit until it is satisfactorily dealt with. If the fault cannot be corrected immediately but it is necessary to continue operation, an adequate temporary solution shall be used. This shall be reported to the owner of the equipment so all parties are advised.

Initial safety checks shall include:

- that capacitors are discharged: this shall be done in a safe manner to avoid possibility of sparking;
- that no live electrical components and wiring are exposed while charging, recovering or purging the system;
- that there is continuity of earth bonding.

DD.5 Sealed electrical components

Sealed electrical components shall not be repaired.

DD.6 Cabling

Check that cabling will not be subject to wear, corrosion, excessive pressure, vibration, sharp edges or any other adverse environmental effects. The check shall also take into account the effects of ageing or continual vibration from sources such as compressors or fans.

DD.7 Detection of flammable refrigerants

Under no circumstances shall potential sources of ignition be used in the searching for or detection of refrigerant leaks. A halide torch (or any other detector using a naked flame) shall not be used.

The following leak detection methods are deemed acceptable for all refrigerant systems.

Electronic leak detectors may be used to detect refrigerant leaks but, in the case of **flammable refrigerants**, the sensitivity can be inadequate or can require re-calibration. (Detection equipment shall be calibrated in a refrigerant-free area.) Ensure that the detector is not a potential source of ignition and is suitable for the refrigerant used. Leak detection equipment shall be set at a percentage of the **LFL** of the refrigerant and shall be calibrated to the refrigerant employed, and the appropriate percentage of gas (25 % maximum) is confirmed.

Leak detection fluids are also suitable for use with most refrigerants but the use of detergents containing chlorine shall be avoided as the chlorine can react with the refrigerant and corrode the copper pipe-work.

NOTE Examples of leak detection methods are

- bubble method,
- fluorescent agent method.

If a leak is suspected, all naked flames shall be removed/extinguished.

If a leakage of refrigerant is found which requires brazing, all of the refrigerant shall be recovered from the system, or isolated (by means of shut-off valves) in a part of the system remote from the leak. Removal of refrigerant shall be according to Clause DD.8.

DD.8 Refrigerant removal and circuit evacuation

When breaking into the refrigerant circuit to make repairs – or for any other purpose – conventional procedures shall be used. However, for **flammable refrigerants** it is important that best practice is followed since flammability is a consideration. The following procedure shall be adhered to:

- safely remove refrigerant. Local and national regulations can apply;
- evacuate;
- purge the circuit with inert gas (optional for A2L);
- evacuate (optional for A2L);
- continuously flush with inert gas when using flame to open circuit;
- open the circuit.

The **refrigerant charge** shall be recovered into the correct recovery cylinders.

The manufacturer shall specify the inert gases that can be used. Compressed air or oxygen shall not be used for purging refrigerant systems.

NOTE An example of an inert gas is dry nitrogen.

Purging of the refrigerant circuit shall be achieved by breaking the vacuum in the system with inert gas and continuing to fill until the working pressure is achieved, then releasing to atmosphere, and finally pulling down to a vacuum. This process shall be repeated until no refrigerant is within the system. The system shall be vented down to atmospheric pressure to enable work to take place.

Ensure that the outlet of the vacuum pump is not close to any potential ignition sources and that ventilation is available.

DD.9 Charging procedures

In addition to conventional charging procedures, the following requirements shall be followed.

- Ensure that contamination of different refrigerants does not occur when using charging equipment. Hoses or lines shall be as short as possible to minimise the amount of refrigerant contained in them.
- Cylinders shall be kept in an appropriate position according to the instructions.
- Ensure that the **refrigerating system** is earthed prior to charging the system with refrigerant.
- Label the system when charging is complete (if not already labelled).
- Extreme care shall be taken not to overfill the **refrigerating system**.

Prior to recharging the system, it shall be pressure-tested with the appropriate purging gas. The system shall be leak-tested on completion of charging but prior to commissioning. A follow up leak test shall be carried out prior to leaving the site.

DD.10 Decommissioning

Before carrying out this procedure, it is essential that the technician is completely familiar with the equipment and all its detail. It is recommended good practice that all refrigerants are recovered safely. Prior to the task being carried out, an oil and refrigerant sample shall be taken in case analysis is required prior to re-use of the recovered refrigerant. It is essential that electrical power is available before the task is commenced.

- 1) Become familiar with the equipment and its operation.
- 2) Isolate the system electrically.
- 3) Before attempting the procedure, ensure that:
 - a) mechanical handling equipment is available, if required, for handling refrigerant cylinders;
 - b) all personal protective equipment is available and being used correctly;
 - c) the recovery process is supervised at all times by a competent person;
 - d) recovery equipment and cylinders conform to the appropriate standards.
- 4) Pump down the refrigerant system, if possible.
- 5) If a vacuum is not possible, make a manifold so that refrigerant can be removed from various parts of the system.
- 6) Make sure that the cylinder is situated on the scales before recovery takes place.
- 7) Start the recovery machine and operate in accordance with instructions.
- 8) Do not overfill cylinders (no more than 80 % volume liquid charge).
- 9) Do not exceed the maximum working pressure of the cylinder, even temporarily.
- 10) When the cylinders have been filled correctly and the process completed, make sure that the cylinders and the equipment are removed from site promptly and all isolation valves on the equipment are closed off.
- 11) The recovered refrigerant shall not be charged into another **refrigerating system** unless it has been cleaned and checked.

DD.11 Labelling

Equipment shall be labelled stating that it has been decommissioned and emptied of refrigerant. The label shall be dated and signed. For appliances containing **flammable refrigerants**, ensure that there are labels on the equipment stating the equipment contains **flammable refrigerant**.

DD.12 Recovery

When removing refrigerant from a system, either for servicing or decommissioning, it is required to follow good practice so that all refrigerants are removed safely.

When transferring refrigerant into cylinders, ensure that only appropriate refrigerant recovery cylinders are employed. Ensure that the correct number of cylinders for holding the total system charge is available. All cylinders to be used are designated for the recovered refrigerant and labelled for that refrigerant (i.e. special cylinders for the recovery of refrigerant). Cylinders shall be complete with pressure-relief valve and associated shut-off valves in good working order. Empty recovery cylinders are evacuated and, if possible, cooled before recovery occurs.

The recovery equipment shall be in good working order with a set of instructions concerning the equipment that is at hand and shall be suitable for the recovery of the **flammable refrigerant**. Consult manufacturer if in doubt. In addition, a set of calibrated weighing scales shall be available and in good working order. Hoses shall be complete with leak-free disconnect couplings and in good condition.

The recovered refrigerant shall be processed in the correct recovery cylinder, and the relevant waste transfer note arranged. Local legislation can apply. Do not mix refrigerants in recovery units and especially not in cylinders.

If compressors or compressor oils are to be removed, ensure that they have been evacuated to an acceptable level to make certain that **flammable refrigerant** does not remain within the lubricant. The compressor body shall not be heated by an open flame or other ignition sources to accelerate this process. Draining of oil from a system shall be carried out safely.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex EE (normative)

Pressure tests

EE.1 General

All **refrigerating system** parts shall withstand the maximum pressure in **normal operation**, abnormal operation, and standstill.

The **maximum allowable pressure** marked on the system shall be not less than the maximum pressure developed during operation under Clause 11, under Clause 19 and during standstill (see Clause EE.2).

It is not necessary for a compressor tested and found to comply with IEC 60335-2-34 to be additionally tested.

Compliance is checked by the tests in Clause EE.3 or Clause EE.4.

*All tested samples shall not leak. Where gaskets are employed for sealing parts under pressure, leakage at gaskets is acceptable, provided the leakage only occurs at a value greater than 120 % of the **maximum allowable pressure** and the test pressure is still reached for the specified time. Additional sealing measures, such as an "O" ring, for pressure testing may be provided.*

It is not necessary for pressure gauges and control mechanisms to be subjected to the test, provided the parts meet the requirements of the component.

EE.2 Determination of standstill pressure

In order to determine the standstill pressure, the appliance shall be soaked in the highest operating temperature specified by the manufacturer for 1 h with power off.

*A **refrigerating system** component that is exposed only to low side pressure can be exposed to a higher pressure under the condition of standstill than under **normal operation**.*

EE.3 Strength pressure test

*The test pressure shall be at least three times the marked **maximum allowable pressure**.*

The pressure test shall be carried out on three samples of each component. The test samples are filled with a liquid, such as water, to exclude air and are connected in a hydraulic pump system. The pressure is raised gradually until the required test pressure is reached. The pressure is maintained for at least 1 min.

EE.4 Fatigue test

*The components shall be subjected to a test at 2 times the marked **maximum allowable pressure**, provided the components comply with the fatigue test. This test is conducted on a separate sample.*

Three samples of each refrigerant-containing part shall be tested. The total number of cycles shall be 250 000.

The test samples shall be filled with fluid and shall be connected to a pressure-driving source. The pressure shall be raised and lowered between the upper and lower cyclic values at a rate specified by the manufacturer. The pressure shall reach the specified upper and lower values during each cycle. The shape of the pressure cycle shall be such that the upper and lower pressure values shall be maintained for at least 0,1 s.

NOTE 1 For safety purposes, a non-compressible fluid can be used for the test. The fluid fills the sample completely to prevent any significant remaining gas.

If the operating temperatures of the appliance under the conditions of steady state operation of Clause 11 are less than or equal to 125 °C for copper or aluminium, or 200 °C for steel, the test temperature of the component part or assembly shall be at least 20 °C. If the continuous operating temperature of the component exceeds 125 °C for copper or aluminium, or 200 °C for steel, the test temperature of the parts or assemblies that are at these temperatures, and subjected to the pressure, shall be at least 25 K greater than the temperature of the part measured during the test of Clause 11 for copper or aluminium and 60 K higher for steel. For other materials, the effects of temperature on the material fatigue characteristics shall be evaluated by conducting the test at the higher temperatures and considering the material characteristics at the higher temperatures.

*The pressure for the first cycle shall be the marked **maximum allowable pressure**.*

The pressure for the test cycles shall be as follows:

- a) *For components subject to high side pressures, the upper pressure value shall not be less than the saturated vapour pressure of the refrigerant at 50 °C and the lower pressure value shall not be greater than the saturated vapour pressure of the refrigerant at 5 °C. For **sanitary hot water heat pumps**, the upper pressure shall not be less than 80 % of the marked **maximum allowable pressure** under the conditions of Clause 11.*
- b) *For components subjected to only low side pressures, the upper pressure value shall not be less than the saturated vapour pressure of the refrigerant at 30 °C and the lower pressure value shall be between 0 bar and the greater of 4,0 bar or the saturated vapour pressure of the refrigerant at –13 °C.*

NOTE 2 The objective is to avoid a test value that is a negative pressure but to require a lower pressure value of the saturated vapour pressure at –13 °C or 4,0 bar, whichever is greater.

For the final test cycle, the test pressure shall be to two times the pressure determined in a) or b).

Annex FF (normative)

Leak simulation tests

FF.1 General

A leakage of refrigerant is simulated in the **refrigerating system** at the **potential leak points**. The method to simulate a leakage at the **potential leak points** is to inject refrigerant vapour through a suitable capillary tube at that point. Where **LFL** is referenced in this annex, the **LFL** shall be taken at the nominal composition as specified in Annex BB.

Piping are not considered to be **potential leak points** within the area of the appliance to be evaluated if they comply with all of the following:

- are protected from potential damage during **normal operation**, service and maintenance;
- have no connecting joints;
- have no bends with centreline bend radius less than 2,5 times the external pipe diameter.

FF.2 Test methods

FF.2.1 The appliance is modified by introducing a simulated leak through a capillary tube.

The quantity of refrigerant leaked, m_{FF} , is equal to the smallest of:

- the **refrigerant charge**, m_C ;
- the **releasable charge**, m_{rl} , as determined by Annex QQ;
- for parts of **enhanced tightness refrigerating systems** which can leak into an indoor space using **A2L refrigerant**, 10 kg;
- for parts of **enhanced tightness refrigerating systems** which can leak into an indoor space using A2 or A3, the amount that will leak during 1 h with the leak rate $\dot{m}_{leak}$ of GG.14.3.

The leak rate shall be maintained at 25 % $\pm$ 5 % of the refrigerant leaked, m_{FF} , per minute.

For parts of **enhanced tightness refrigerating systems** which can leak into an indoor space, the leak rate shall be maintained at 10 kg per hour for **A2L refrigerants** or the leak rate $\dot{m}_{leak}$ of GG.14.3 for A2 and A3 refrigerants.

The leak shall be maintained until the quantity of refrigerant leaked, m_{FF} , has leaked.

The refrigerant is injected at the most unfavourable **potential leak point** and the most unfavourable direction at ambient temperature (15 °C to 35 °C).

FF.2.2 During this test, the appliance is switched off or operated under **normal operation** at **rated voltage**. If airflow is activated before any potential ignition sources are activated, then the test is not conducted with the appliance switched off. During a test where the appliance is operating, refrigerant gas injection is started at the same time as the appliance is switched on.

In "switched off" mode, the appliance shall remain connected to the mains and safety mitigation controls, such as **refrigerant detection system** and **circulation airflow** or **safety shut-off valves**, shall be allowed to function as intended.

FF.2.3 For refrigerant blends, the test shall be carried out using the nominal composition as defined in Annex BB.

If a zeotropic blend is used, the test is conducted maintaining the composition within a reasonable range. It is acceptable to use liquid phase of the blend extracted from the bottle then evaporated. Gas phase release with the pressure regulator from a large mixed gas tank is the best method, but care shall be taken to avoid any condensation occurring in the vessel.

FF.2.4 The test is conducted in a room that is draught-free and of sufficient size to conduct the test.

The minimum volume (V) is:

$$V = (15 \times m_{FF}) / \text{LFL} \quad (\text{FF.1})$$

where

V is the minimum volume in m^3 with a ceiling height not less than 2,2 m;

m_{FF} is the quantity of refrigerant leaked as defined in FF.2.1 in kg;

LFL is the **lower flammability** limit in kg/m^3 .

The quantity of gas injected shall be measured with acceptable accuracy. Weighing the bottle is required.

Care shall be taken that the installation of the capillary tube does not unduly influence the results of the test and that the structure of the appliance does not unduly influence the results of the test.

The instrument used for monitoring the refrigerant gas concentration shall have a $t(90)$ response time of faster than 30 s and shall be located so as to not unduly influence the results of the test.

If gas chromatography is used to measure the refrigerant gas concentrations, the gas sampling in confined areas shall not exceed 2 ml every 30 s.

FF.2.5 The measured concentration of refrigerant gas surrounding any component that can be an ignition source shall not exceed 25 % of the LFL of the refrigerant gas, and shall not exceed 15 % of the LFL of the refrigerant gas for a time period of 5 min during and after the amount has been injected.

Annex GG (normative)

Charge limits, ventilation requirements and requirements for secondary circuits

GG.1 Requirements for refrigerant charge limits

GG.1.1 General

When a **flammable refrigerant** is used, the requirements for the installation space of the appliance and/or ventilation requirements are determined according to

- the **refrigerant charge** (m_c) used in the appliance,
- the **releasable charge** (m_{rl}),
- the installation location,
- the type of ventilation of the location or of the appliance.

For appliances with multiple **refrigerating systems**, each **refrigerating system** shall be evaluated independently.

Where multiple values of A_{min} are found based on different **operating states**, the highest value shall be A_{min} for the appliance.

NOTE 1 This can be the case when different measures are used under different **operating states**, for example when continuous airflow is applied during an active operation state, and **releasable charge** is applied during standstill.

Where the parameters **lower flammability limit (LFL)** and molecular weight (M) are referenced in Annex GG, the values used shall be based on worst case formulation (WCF) as specified in Annex BB.

Toxicity charge limits shall be determined in accordance with ISO 5149-1:2014, ISO 5149-1:2014/AMD1:2015, and ISO 5149-1:2014/AMD2:2021. If the toxicity-based charge limits are less than the flammability-based charge limits, the toxicity charge limits shall take precedence.

For appliances with a **refrigerant charge** of $m_c \leq m_1$, no minimum room area is required and Clause GG.6 does not apply.

For appliances where leaked refrigerant does not enter the indoor space, no minimum room area is required.

If **releasable charge** is determined by Annex QQ:

- for **releasable charge** $m_{rl} \leq m_1$, there is no requirement for minimum room area, A_{min} , and Clause GG.6 does not apply;
- for **releasable charge** $m_{rl} > m_1$, each **operating state** of the **refrigerating system** shall comply with at least one of the following clauses: GG.2, GG.3, GG.4, GG.7, GG.9, and GG.14. The **refrigerant charge** m_c shall be replaced by the **releasable charge** m_{rl} in the formulae of Annex GG.

NOTE 2 Table GG.1 is provided as guidance when applying Annex GG. The column for indoor or outdoor application is determined. The requirements are identified in the appropriate box where the product and installation requirements are identified.

NOTE 3 The requirements applicable to a higher **refrigerant charge** can be applied for each range in Table GG.1.

Table GG.1 – Outline of Annex GG

Refrigerant charge	Direct system ^a			Indirect system ^b
	Indoor space		Outdoors	
	Refrigerant charge and room area	Refrigerant charge, room area and additional requirements	Additional ventilation	
$m_c \leq m_1$ or $m_{rl} \leq m_1$	No room size restriction			No room size restriction, Clause GG.6
$m_1 < m_c \leq 2 \times m_1$ (appliances which are not fixed appliances)	Not allowed	Clause GG.7	Not allowed	
$m_1 < m_c \leq m_2$	GG.2.1	GG.2.2 ^c , GG.2.3 ^d , Clause GG.9 ^c , Clause GG.10 ^c , Clause GG.14 ^d	Clause GG.3, Clause GG.8 ^c , Clause GG.10 ^c	
$m_2 < m_c \leq m_3$	Not allowed	Clause GG.9 ^c , Clause GG.10 ^c	Clause GG.3, Clause GG.8 ^c , Clause GG.10 ^c	
$m_c > m_3$	Beyond the scope of this standard. National standards apply.			

^a Direct system means a **refrigerating system** in which a single rupture of the refrigerant circuit results in a refrigerant release to an indoor space, irrespective of the location of the refrigerant circuit.

^b Indirect system means a **refrigerating system** in which a single rupture of the refrigerant circuit does not leak into an indoor space, irrespective of the location of the refrigerant circuit.

^c These clauses are only applicable to appliances with **A2L refrigerant**.

^d These clauses are only applicable to appliances with A2 or A3 refrigerant.

GG.1.2 Determination of the refrigerant capped quantity limit

For A2 and A3 refrigerants, m_1 , m_2 , m_3 are defined as follows:

$$m_1 = 4 \times \text{LFL} \quad (\text{GG.1})$$

$$m_2 = 26 \times \text{LFL} \quad (\text{GG.2})$$

$$m_3 = 130 \times \text{LFL} \quad (\text{GG.3})$$

where LFL is the **lower flammability limit** in kg/m³ for the refrigerant used.

For **A2L refrigerants**, m_1 , m_2 , m_3 are defined as follows:

$$m_1 = 6 \times \text{LFL} \quad (\text{GG.4})$$

$$m_2 = 52 \times \text{LFL} \quad (\text{GG.5})$$

$$m_3 = 260 \times \text{LFL} \quad (\text{GG.6})$$

where LFL is the **lower flammable limit** in kg/m³ for the refrigerant used.

NOTE The factors in the formulae are in m³.

GG.1.3 Determination of unventilated room area

GG.1.3.1 General

For the purpose of determination of room area (A) when used to calculate the **maximum refrigerant charge** (m_{max}) in an unventilated space, the following shall apply.

The room area (A) shall be defined as the room area enclosed by the projection to the floor of the walls, partitions and doors of the space in which the appliance is installed.

Spaces connected by only drop ceilings, ductwork, or similar connections shall not be considered a single space.

GG.1.3.2 Determination of unventilated room area for appliances using A2L refrigerant

For units mounted higher than 1,6 m, and in compliance with GG.2.2, spaces divided by partition walls which are no higher than 1,6 m shall be considered a single space.

For **fixed appliances**, rooms on the same floor and connected by an open passageway between the spaces can be considered a single room when determining compliance to A_{min} , if the passageway complies with all of the following:

- it is a permanent opening;
- it extends to the floor;
- it is intended for people to walk through.

For **fixed appliances**, the area of the adjacent rooms, on the same floor, connected by permanent opening in the walls and/or doors between occupied spaces, including gaps between the wall and the floor, can be considered a single room when determining compliance to A_{min} , provided all of the following are met.

- The space shall have appropriate openings according to GG.1.4.
- The minimum opening area for natural ventilation, $A_{\text{nv,min}}$, shall not be less than the following:

$$A_{\text{nv,min}} = \frac{m_c - m_{\text{max}}}{\text{LFL} \times 104} \times \sqrt{\frac{A}{g \times m_{\text{max}}}} \times \frac{M}{M - 29} \quad (\text{GG.7})$$

where

- $A_{nv,min}$ is the minimum opening for natural ventilation in m^2 ;
- m_c is the actual **refrigerant charge** of refrigerant in the system in kg;
- m_{max} is the allowable **maximum refrigerant charge** in the system in kg, calculated according to Formula (GG.8) or m_2 , whichever is lower;
- LFL is the **lower flammability limit** in kg/m^3 ;
- A is the room area in m^2 ;
- M is the molar mass of the refrigerant in $kg/kmol$;
- g is the gravity acceleration of $9,81 m/s^2$;
- 29 is the average molar mass of air in $kg/kmol$;
- 104 is a constant.

GG.1.3.3 Determination of unventilated room area for appliances using A2 and A3 refrigerant

For determining compliance to A_{min} for **fixed appliances** with release height, h_0 , according to GG.2.1, not less than 1,6 m, rooms on the same floor and connected by an open passageway between the spaces can be considered a single room if the passageway complies with all of the following:

- it is a permanent opening;
- it extends to the floor;
- it is intended for people to walk through.

For determining compliance to A_{min} for **fixed appliances** and with release height, h_0 , according to GG.2.1, less than 1,6 m or **fixed appliances** with **circulation airflow** at any release height, h_0 , rooms on the same floor and connected by an open passageway between the spaces can be considered a single room with an area of the space that the refrigerant can leak directly into plus half of the area of the connected space, if all of the following is complied with:

- the area of the space in which the unit is installed shall not be less than 20 % of A_{min} ;
- the passageway is a permanent opening;
- the passageway extends to the floor;
- the passageway is intended for people to walk through.

GG.1.4 Opening conditions for connected rooms and natural ventilation for appliances using A2L refrigerants

When the openings for connected rooms or natural ventilation are required, the following conditions shall be applied for the lower opening.

- The area of any openings above 300 mm from the floor shall not be considered in determining compliance with $A_{nv,min}$.
- At least 50 % of the required opening area $A_{nv,min}$ shall be below 200 mm from the floor.
- The bottom of the lowest openings shall not be higher than the point of release when the unit is installed and not more than 100 mm from the floor.
- For openings extending to the floor, the height shall not be less than 20 mm above the surface of the floor covering.

A second higher opening shall be provided. The total size of the second opening shall not be less than 50 % of minimum opening area for $A_{nv,min}$ and shall be at least 1,5 m above the floor.

Openings shall be permanent openings which cannot be closed.

NOTE The requirement for the second opening can be met by drop ceilings, ventilation ducts, or similar arrangements that provide an airflow path between the connected rooms.

GG.2 Requirements for charge limits in unventilated areas

GG.2.1 General

Clause GG.2 is applicable for appliances with a **refrigerant charge** of $m_1 < m_c \leq m_2$ and for **factory sealed single package units** which are not **fixed appliances** with a **refrigerant charge** of $m_1 < m_c \leq 2 \times m_1$. See Figure GG.1.

For **factory sealed single package units** which are not **fixed appliances** with a **refrigerant charge** of $m_1 < m_c \leq 2 \times m_1$, the requirements of Clause GG.7 apply.

For systems using **A2L refrigerants** with a **refrigerant charge** of $m_1 < m_c \leq m_3$ that comply with the conditions in 22.125, the requirements of Clause GG.10 can apply.

For systems using A2 or A3 refrigerants with a **refrigerant charge** of $m_1 < m_c \leq m_2$ that comply with the conditions in 22.125, the requirements of Clause GG.14 can apply.

For other appliances with a **refrigerant charge** of $m_1 < m_c \leq m_2$:

The **maximum refrigerant charge** in a room shall be in accordance with the following:

$$m_{\max} = 2,5 \times (\text{LFL})^{(5/4)} \times h_0 \times (A)^{1/2}, \text{ not to exceed } m_{\max} = \text{CF} \times \text{LFL} \times h_0 \times A \quad (\text{GG.8})$$

or the required minimum room area $A_{\min}$ to install an appliance with **refrigerant charge** m_c (kg) shall be in accordance with following:

$$A_{\min} = (m_c / (2,5 \times (\text{LFL})^{(5/4)} \times h_0))^2, \text{ not less than } A_{\min} = m_c / (\text{CF} \times \text{LFL} \times h_0) \quad (\text{GG.9})$$

where

$m_{\max}$ is the allowable **maximum refrigerant charge** in a room, in kg;

m_c is the **refrigerant charge** in the appliance, in kg;

$A_{\min}$ is the required minimum room area, in m²;

A is the room area, in m²;

2,5 is a constant;

LFL is the **lower flammability limit**, in kg/m³;

CF is a concentration factor with a value of 0,75 for **refrigerating systems** using **A2L refrigerant** and a value of 0,5 for **refrigerating systems** using A2 or A3 refrigerant;

h_0 is the release height, the vertical distance in metres from the floor to the point of release when the appliance is installed (see Figure GG.3). $h_0 = (h_{\text{inst}} + h_{\text{rel}})$ or 0,6 m, whichever is higher.

h_{rel} is the **release offset** in metres from the bottom of the appliance to the point of release (see Figure GG.3). Cumulative openings smaller than 5 cm² and openings with a single dimension of not more than 0,1 mm are not considered as openings where leaking refrigerant can escape. Openings for routing of wires and tubing which are not sealed openings shall include the total area of the opening without consideration of the area occupied by the tubing or wire.

h_{inst} is the **installed height** in metres of the unit (see Figure GG.3).

Reference **installed heights** are given below:

$h_{inst} = 0,0$ m for portable and floor mounted;

$h_{inst} = 1,0$ m for window mounted;

$h_{inst} = 1,8$ m for wall mounted;

$h_{inst} = 2,2$ m for ceiling mounted.

If the minimum **installed height** given by the manufacturer is higher than the reference **installed height**, then in addition A_{min} and m_{max} for the reference **installed height** shall be given by the manufacturer. An appliance may have multiple reference **installed heights**. In this case, A_{min} and m_{max} calculations shall be provided for all applicable reference **installed heights**.

For appliances serving one or more rooms with an air duct system, the lowest opening of the duct connection to each conditioned space or any opening of the indoor unit greater than 5 cm², at the lowest position to the space, shall be used for h_0 . However, h_0 shall not be less than 0,6 m. A_{min} shall be calculated as a function of the opening heights of the duct to the spaces and the **refrigerant charge** for the spaces where leaked refrigerant can flow to, considering where the unit is located. A_{min} shall be calculated for the spaces where a duct is connected, or an indoor unit is located. If all spaces have room area not less than A_{min} , no further measure is required. If any room area of spaces is below A_{min} , measures according to Clause GG.8 or Clause GG.9 shall be provided for appliances using **A2L refrigerants**.

GG.2.2 Fixed appliances using A2L refrigerants with integral circulation airflow

GG.2.2.1 General

When the fan integrated into an appliance is continuously operated or operation is initiated by a **leak detection system** with a sufficient **circulation airflow** (see also Table GG.2), the **maximum refrigerant charge** can be increased, or minimum room area can be reduced according to the following:

The **maximum refrigerant charge** in a room shall be in accordance with the following:

$$m_{max} = CF \times LFL \times h_{ra} \times A \quad (GG.10)$$

or the required minimum room area A_{min} of the installed appliance with **refrigerant charge** m_c (kg) shall be in accordance with the following:

$$A_{min} = m_c / (CF \times LFL \times h_{ra}) \quad (GG.11)$$

where

CF is a concentration factor with a value of 0,75;

$m_{\max}$ is the allowable **maximum refrigerant charge** in the system in kg;

m_c is the actual **refrigerant charge** in the system in kg;

$A_{\min}$ is the required minimum room area in m²;

h_{ra} is the estimated reaching height of airflow (see Table GG.2) in m;

A is the room area in m²;

LFL is the **lower flammability limit** in kg/m³.

If the space has a room area not less than $A_{\min}$, no further measure is required. If the room area of the space is below $A_{\min}$, measures according to Clause GG.8 shall be applied.

Table GG.2 – Circulation airflow

Appliances	Airflow direction ϕ^c (°)	Airflow		Estimated reaching height h_{ra}^b (m)
		Minimum velocity ^a v (m/s)	Minimum airflow Q_{min} (m³/h)	
All	Downwards – 90° ≤ φ ≤ 0°	1	30 × m _c /LFL	h_a
Installed with lower edge of air inlet within 0,2 m from the floor	Upwards 0° < φ ≤ 90°			$h_a + h_d$

h_a is the height of the upper edge of the air discharge opening in m;

h_d is the dynamic reaching height of airflow in m.

^a Velocity shall be calculated as the airflow divided by the nominal face area of the outlet. The grille area shall not be deducted.

^b h_{ra} shall not exceed 2,2 m.

^c See Figure GG.4 for examples.

$$h_d = \left(1 + \frac{2,35}{\text{LFL} \left(1 - \frac{1,2}{\rho} \right) + 0,05} \right) \times (0,0183 \times v^2 \times \sin^2 \phi) \quad (\text{GG.12})$$

where

v is the **circulation airflow** velocity in m/s;

ϕ is the **circulation airflow** elevation angle from horizontal in degrees ($0^\circ \leq \phi \leq 90^\circ$);

LFL is the **lower flammability limit** in kg/m³;

ρ is the gas density of the refrigerant at atmospheric pressure and 25 °C in kg/m³.

See Figure GG.4.

Compliance is checked by testing.

Operation of **circulation airflow** shall comply with either GG.2.2.2 or GG.2.2.3.

GG.2.2.2 Continuous circulation airflow

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below $Q_{\min}$, the following actions shall be taken:

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.2.2.3 Circulation airflow activated by a leak detection system

If a **leak detection system** is activated, the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the fan(s) of the appliance to deliver indoor airflow at or above the minimum airflow $Q_{\min}$;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.2.3 Fixed appliances using A2/A3 refrigerants with integral circulation airflow

GG.2.3.1 General

When the fan integrated into an appliance is continuously operated or operation is initiated by a **leak detection system** with sufficient airflow rate, the **maximum refrigerant charge** can be increased or minimum room area can be reduced according to following.

The **maximum refrigerant charge** in a room shall be in accordance with the following:

$$m_{\max} = CF \times LFL \times A \times 2,2 \quad (\text{GG.13})$$

or the required minimum room area $A_{\min}$ of installed appliance with **refrigerant charge** m_c (kg) shall be in accordance with following:

$$A_{\min} = m_c / (CF \times LFL \times 2,2) \quad (\text{GG.14})$$

where

$m_{\max}$ is the allowable **maximum refrigerant charge** in the system in kg;

CF is a concentration factor specified by the manufacturer and not exceeding 0,5. CF shall be the same value as used in the formula for calculating $Q_{\min}$ in Formula (GG.15);

m_c is the actual **refrigerant charge** in the system in kg;

$A_{\min}$ is the required minimum room area in m²;

2,2 is the room height in m;

A is the room area in m^2 ;

LFL is the **lower flammability limit** in kg/m^3 .

NOTE A lower value of CF can be specified to give a lower airflow requirement, and it results in a higher $A_{\min}$ and lower $m_{\max}$.

The fan integrated into an appliance shall have a minimum **circulation airflow** according to:

$$Q_{\min} = 3\,600 \frac{8Y\sqrt{A_o}}{240} \left(\frac{m_c}{\text{LFL}} \right)^{3/4} \left(\frac{\text{CF}^{1/4}}{1 - \text{CF}} \right) \quad (\text{GG.15})$$

where

$Q_{\min}$ is the required airflow volume in m^3/h ;

3 600 is a constant to convert m^3/s to m^3/h ;

8 is a constant;

A_o is the airflow discharge area of the appliance in m^2 . The value is the nominal face area of the outlet. The grille area shall not be deducted;

240 is a constant based on leaking the total **refrigerant charge** in 4 min;

m_c is the actual **refrigerant charge** amount in the system in kg;

LFL is the **lower flammability limit** in kg/m^3 ;

Y is a constant, if there are leak sources outside the unit $Y = 1,5$, otherwise $Y = 1$;

CF is a concentration factor specified by the manufacturer and not exceeding 0,5. The value shall be the value as used in Formula (GG.13) and Formula (GG.14) for calculating $m_{\max}$ and $A_{\min}$.

Compliance is checked by testing.

Operation of **circulation airflow** shall comply with either GG.2.3.2 or GG.2.3.3.

GG.2.3.2 Continuous circulation airflow

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below $Q_{\min}$, the following actions shall be taken:

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.2.3.3 Circulation airflow activated by a leak detection system

If a **leak detection system** is activated, the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the fan(s) of the appliance to deliver indoor airflow at or above the minimum airflow $Q_{\min}$;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.3 Requirements for charge limits in areas with mechanical ventilation

Clause GG.3 is applicable for appliances with a **refrigerant charge** of $m_1 < m_c \leq m_3$.

See Figure GG.2.

Mechanical ventilation applies to **fixed appliances** only.

Mechanical ventilation occurs when the appliance enclosure or the room is provided with a ventilating system that, in the event of a leak, is intended to vent refrigerant into an area where there is not a potential ignition source and the gas can be readily dispersed. The appliance enclosure shall have a ventilation system that produces airflow within the appliance enclosure and meets the requirements of Clause GG.4 or is intended to be installed in a room that meets the requirements of Clause GG.5.

GG.4 Requirements for mechanical ventilation within the appliance enclosure

The refrigerating circuit is provided with a separate enclosure that does not allow flow from inside the enclosure to the room. The appliance enclosure shall have a ventilation system that produces airflow from the appliance interior to the outside through an exhaust ventilation duct. The manufacturer shall specify the exhaust ventilation duct dimensions, the maximum length and number of bends. The negative pressure measurement in the interior of the appliance enclosure shall be 20 Pa or more and the flow rate to the exterior with open enclosure and attached maximum ventilation duct shall be at least $Q_{\min}$:

$$Q_{\min} = 3\,600 \times 1 / CF \times 24,5 / M \times \dot{m}_{\text{leak}} \text{ (with a minimum of } 2 \text{ m}^3/\text{h}) \quad (\text{GG.16})$$

where

3 600 is a conversion of seconds to hours;

CF is a concentration factor with a value of 0,25;

M is the molar mass of refrigerant in kg/kmol;

$Q_{\min}$ is the minimum required volume flow of the ventilation in m^3/h ;

24,5 is the universal gas constant R multiplied by temperature of 298 K (25 °C) and divided by pressure of 101,325 kPa in l/mol;

$\dot{m}_{\text{leak}}$ is the leak rate in kg/s.

For **refrigerating systems** which are not **enhanced tightness refrigerating systems**, the leak rate, $\dot{m}_{\text{leak}}$, shall be determined as:

$$\dot{m}_{\text{leak}} = m_c / 240 \quad (\text{GG.17})$$

where

m_c is the **refrigerant charge** in kg;

240 is the 4 min release time in s.

For **enhanced tightness refrigerating systems**, the leak rate, $\dot{m}_{\text{leak}}$, shall be determined as:

- for **A2L refrigerants** $\dot{m}_{\text{leak}} = 0,002\,78\text{ kg/s}$,
- for A2 and A3 refrigerants, the values of GG.14.3.1, Table GG.6, in kg/s.

Ventilation shall be to the outside or to a room with a minimum volume as specified in Clause GG.2, Formula (GG.9).

The ventilation shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below Q_{min} , the following actions shall be taken:

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released into the enclosure.

Or:

The ventilation is switched on by a **leak detection system** and the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the fan(s) of the appliance to deliver airflow at or above the minimum airflow Q_{min} ;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the enclosure.

Compliance for the appliance ventilation system is checked by the following tests.

The appliance shall be installed in accordance with the instructions and the ventilation shaft shall not exceed the maximum length and number of bends specified by the manufacturer.

The room shall be at least 10 times the volume of the appliance and with sufficient make-up air to replace any air exhausted during the test. The air pressure differential is measured between the interior of the appliance enclosure and the room. The airflow rate shall be measured at the outside end of the ventilation shaft.

GG.5 Requirements for mechanical ventilation for rooms complying with ISO 5149-3

Machinery rooms shall meet the requirements of ISO 5149-3:2014, Clause 5 and ISO 5149-3:2014/AMD1:2021, 5.13, 5.14 and 5.15.

GG.6 Requirements for refrigerating systems employing secondary heat exchangers

If a **flammable refrigerant** is used and the system contains a secondary **heat exchanger**, the **heat exchanger** shall not allow the release of refrigerant into areas served by the secondary **heat exchanger** fluid. Compliance shall be met by at least one of the following:

- an open loop secondary system vented to the outside; or

- an automatic air/refrigerant separator and pressure relief valve is placed in the secondary circuit on the outlet pipe from the **evaporator** or the **condenser**. The air/refrigerant separator and pressure relief valve is at a high level relative to the outlet of the **heat exchanger** where leaked refrigerant can accumulate. The pressure relief valve shall have a flow rating rated to discharge the refrigerant that can be released through the **heat exchanger**. The air/refrigerant separator and pressure relief valve shall discharge the refrigerant into a space compliant with the charge limitations in Annex GG or to the outside; or
- a **double wall heat exchanger**, or
- a refrigerant system where the pressure of the secondary circuit is always greater than the pressure of the primary circuit in the area of contact, or
- the bursting of the secondary **heat exchanger** is avoided by
 - 1) specifying requirements for specific properties of the secondary **heat exchanger** fluid to prevent corrosion, including:
 - water: the manufacturer shall specify in the installation instructions the water quality necessary for the specified **heat exchanger**;
 - brine: the manufacturer shall specify in the installation instructions the type of brine and its permitted concentration range for which the **heat exchanger** is suitable.
 - 2) the use of a freezing protection device which considers:
 - fluid freezing point;
 - distribution through the **heat exchanger**;
 - glide of the evaporating refrigerant;
 - service procedures that could lead to freeze damage, for example adding or removing the refrigerant in liquid phase from a **heat exchanger** containing standing water.

*An appliance whose **heat exchangers** can be damaged as a result of freezing (e.g water to water **heat pumps**, water to air **heat pumps** or chillers) shall be tested as follows:*

- a) *The appliance shall be allowed to run under stable conditions. The volume flow through the **evaporator** shall be monitored.*
- b) *The circulation pump will be switched off.*
- c) *The freezing protection device shall switch off the compressor.*
- d) *After 1 min, the circulation pump will be switched on again and the compressor will restart.*
- e) *The procedures of items b) and d) shall be repeated 10 times.*
- f) *After 10 repetitions, the volume flow through the **evaporator** shall not be lower than the flow measured in item a). Measurement tolerance shall be taken into account.*
- g) *The appliance shall be tested with the minimum water flow at the **rated voltage** and frequency under the following temperature conditions.*
 - *The water outlet is set just above the lowest cut out (taking into account tolerances) of the safety devices for protection against freezing of the **evaporator**.*
 - *The **condenser** side is set so as to get the lowest condensation temperature within the **normal operation** range.*
 - *The test equipment shall be set so that there is no automatic adjustment of the water flow on the **evaporator** side.*
 - *The appliance shall operate continuously for a period of 6 h. During 6 h, none of the following conditions, indicating the start of freezing, shall appear:*
 - 1) *the water flow on the **evaporator** side will not drop more than 5 % compared to the initial water flow;*
 - 2) *the evaporating temperature will not drop more than 2 K;*

- 3) *the temperature difference between inlet and outlet water temperature of the **evaporator** will not drop more than 30 % compared to the initial temperature difference.*
- h) *The appliance shall then be tested with a maximum water flow under the conditions described in item g).*

GG.7 Factory sealed single package units which are not fixed appliances with a refrigerant charge of $m_1 < m_c \leq 2 \times m_1$

GG.7.1 Determination of refrigerant charge

For **factory sealed single package units** which are not **fixed appliances** (i.e. one functional unit in one enclosure) with a **refrigerant charge** of $m_1 < m_c \leq 2 \times m_1$, the **maximum refrigerant charge** in a room shall be in accordance with the following:

$$m_{\max} = CF \times A \times LFL \times 2,2 \quad (\text{GG.18})$$

or the required minimum room area, $A_{\min}$, to install an appliance with **refrigerant charge** m_c shall be in accordance with the following:

$$A_{\min} = m_c / (CF \times LFL \times 2,2) \quad (\text{GG.19})$$

where

- CF is a concentration factor with a value of 0,25;
- $m_{\max}$ is the allowable **maximum refrigerant charge** in a room in kg;
- m_c is the **refrigerant charge** in the appliance in kg;
- $A_{\min}$ is the required minimum room area in m²;
- A is the room area in m²;
- LFL is the **lower flammability limit** in kg/m³;
- 2,2 is the minimum ceiling height employed in metres (m).

The appliance can be placed at any height above the floor.

When the appliance is switched on, a fan shall operate continuously supplying a minimum airflow as under normal steady state conditions, even when the compressor is switched off by the **thermostat**.

Compliance is checked by inspection.

GG.7.2 Mechanical requirements

GG.7.2.1 General

The appliance shall withstand the effects of dropping and vibration during transport and normal use without leaking refrigerant.

The appliance is subjected to the tests of GG.7.2.2 to GG.7.2.4. There shall be no refrigerant leakage.

Compliance is checked by the following:

The use of detection equipment having an equivalent sensitivity of 3 g/year of refrigerant shall reveal no leaks.

The tests of GG.7.2.2, GG.7.2.3 and GG.7.2.4 may be carried out on the appliance charged with a non-flammable refrigerant or a non-hazardous gas.

Damage of parts other than the refrigerating circuit is allowed.

GG.7.2.2 Drop test with packaging

The appliance is tested in its final packaging for transport and shall withstand the following number of drops on a horizontal hardwood board 20 mm thick placed on a concrete or similar hard surface:

- one with the appliance held upright;
- one for each of the four edges of the bottom side, with the bottom side forming an angle of about 30° to the horizontal.

The drop height depends on the weight of the appliance according to Table GG.3:

Table GG.3 – Appliance with packaging

Appliance weight kg	Drop height cm
< 10	80
≥ 10 and < 20	60
≥ 20 and < 30	50
≥ 30 and < 40	40
≥ 40 and < 50	30
≥ 50	20

GG.7.2.3 Drop test without packaging

The tests of GG.7.2.3 are repeated on the appliance without its packaging and with the drop height according to Table GG.4:

Table GG.4 – Appliance without packaging

Appliance weight kg	Drop height cm
< 10	20
≥ 10 and < 20	17
≥ 20 and < 30	15
≥ 30 and < 40	12
≥ 40	10

GG.7.2.4 Test after installation

The appliance is installed in accordance with the installation instructions. It is supplied at **rated voltage** or at the upper limit of the **rated voltage range** and operated at ambient temperature.

The appliance is operated for 960 cycles, each cycle consisting of the compressor running for 10 min minimum followed by a rest period of 5 min minimum.

This test may be made on a separate sample.

GG.7.3 Vibration test

Vibrations exceeding 0,30 G RMS, when measured with a low pass filter at 200 Hz, are not allowed in the refrigerant containing pipes under **normal operation**.

Compliance is checked by the following test:

The appliance is installed in accordance with the installation instructions. It is supplied at rated voltage or at the upper limit of the rated voltage range and operated at ambient temperature. The equipment shall be positioned in accordance with the manufacturer's instruction. Testing shall be conducted in fan only mode, and the heating and cooling mode if applicable.

*Vibration level shall be measured over the full range, +5 % of the maximum speed and –5 % of the minimum speed, of the compressor and indoor fan speeds as allowed by the controls at +10 % and –10 % input frequency, in consideration of the operation modes. For compressors and fans with discrete steps in speed, the vibration shall be measured at each step, +10 % and –10 %. If the equipment trips on a **protective device**, the maximum speed and frequency may be reduced until the equipment stays on line as intended. Care shall be taken that the measurement sensors do not influence the line vibration level, and that the rate of change of speed is sufficiently slow that the maximum vibration is captured.*

The vibration is measured at critical points in the piping.

NOTE Critical points are those with a larger vibration amplitude.

This test may be made on a separate sample.

GG.8 Ventilated area requirements for appliances using A2L refrigerants

GG.8.1 General

Clause GG.8 is applicable for appliances with a **refrigerant charge** of $m_1 < m_c \leq m_3$.

Ventilation according to GG.8.2 or GG.8.3 shall be provided when **refrigerant charge** is $m_c > m_{\max}$.

Natural and mechanical ventilation apply to **fixed appliances** only.

GG.8.2 Natural ventilation to outdoors

NOTE 1 Requirements for natural ventilation to the indoors can be found in GG.1.3 and GG.1.4.

If natural ventilation to outdoors is applied, all of the following shall be met:

- Natural ventilation to outdoors is not allowed below ground level.
- Natural ventilation from an occupied space shall not be made to outdoors.

NOTE 2 A user can block the natural ventilation to the outside if it is cold outside.

- The openings for natural ventilation shall comply with GG.1.4.
- The **maximum refrigerant charge** of a system, $m_{\max}$, and minimum opening area, $A_{\text{nv,min}}$, for natural ventilation to outdoors shall be calculated using the following formulae:

$$m_{\max} = \frac{\left(\frac{A_{\text{nv}}}{0,14}\right)^2}{\left(\frac{0,04}{\text{LFL}}\right)} \quad (\text{GG.20})$$

$$A_{\text{nv,min}} = 0,14 \times \sqrt{m_{\text{c}} \times \frac{0,04}{\text{LFL}}} \quad (\text{GG.21})$$

where

- m_{c} is the **refrigerant charge** of a system in kg;
- $m_{\max}$ is the **maximum refrigerant charge** for a system in kg;
- LFL is the **lower flammability limit** in kg/m³;
- A_{nv} is the opening area in m²;
- $A_{\text{nv,min}}$ is the minimum opening area in m²;
- 0,14 is a constant derived from the gravity acceleration, flow coefficient, etc;
- 0,04 is the conversion constant from hydrocarbon LFL to another LFL.

GG.8.3 Mechanical ventilation requirements for rooms with appliances using A2L refrigerants

GG.8.3.1 Operation of mechanical ventilation system

GG.8.3.1.1 General

Mechanical ventilation in compliance with GG.8.3.1.2 or GG.8.3.1.3 shall be provided.

GG.8.3.1.2 Continuous operation of mechanical ventilation system

The mechanical ventilation system shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below $Q_{\min}$, the following actions shall be taken:

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.8.3.1.3 Mechanical ventilation system activated by a leak detection system

If a **leak detection system** is activated, the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the mechanical ventilation system of the appliance to deliver indoor airflow at or above the minimum airflow $Q_{\min}$;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.8.3.2 Required airflow

The airflow shall be calculated using of the formula below. Losses caused by ducts or other components in the air stream shall be considered.

$$Q_{\min} = \frac{m_c - m_{\max}}{4 \times \text{LFL}} \times 2 \times 60 \quad (\text{GG.22})$$

where

- $Q_{\min}$ is the required airflow volume in m^3/h ;
- $m_{\max}$ is the **maximum refrigerant charge** for the system in the room in kg according to Formula (GG.8) or m_2 , whichever is lower, or Clause GG.9, where applicable;
- m_c is the actual **refrigerant charge** of a single **refrigerating system** expressed in kg;
- 4 is the assumed leak time (4 min);
- 2 is a safety factor of 2;
- 60 is the conversion minutes to hours;
- LFL is the **lower flammability limit** in kg/m^3 .

Mechanical ventilation shall be made to the outdoor or an indoor space where the room area is larger than the minimum area of the room which the mechanical ventilation exhausts into, $EA_{\min}$, calculated using the following formula:

$$EA_{\min} = (m_c - m_{\max}) / (\text{CF} \times \text{LFL} \times H) \quad (\text{GG.23})$$

where

- $EA_{\min}$ is the minimum area of the room which the mechanical ventilation exhausts into in m^2 ;
- CF is the concentration factor with a value of 0,25;
- m_c is the **refrigerant charge** in kg;
- $m_{\max}$ is the allowable **maximum refrigerant charge** for the system in the room in kg;
- H is the height of the room = 2,2 m;
- LFL is the **lower flammability limit** in kg/m^3 .

GG.8.3.3 Requirement for opening

For mechanical ventilation as specified in GG.8.3, the lower edge of openings extracting air from the room shall not be more than 100 mm above the floor.

The openings extracting air from the room shall be positioned relative to the openings supplying air to the room such that the supplied makeup air mixes with the leaked refrigerant.

The openings exhausting air from the room shall be positioned relative to the intake openings supplying air to the room to prevent re-circulation back to the room.

GG.9 Charge limits for appliances using A2L refrigerants connected via an air duct system to one or more rooms

GG.9.1 General

Clause GG.9 is applicable for appliances with a **refrigerant charge** of $m_1 < m_c \leq m_3$. The **maximum refrigerant charge** can be increased or the minimum room area can be reduced if the following requirements are met:

- The appliances shall be connected via an air duct system to one or more rooms, the supply and return air shall be directly ducted to the space. Open areas such as false ceilings shall not be used as a return air duct;
- Operation of **circulation airflow** shall comply with either GG.9.2 or GG.9.3.
- $m_{\max}$ shall be determined based on the total area of the conditioned space (TA) connected by ducts taking into consideration that the **circulation airflow** distributed to all the rooms by the appliance integral indoor fan will mix and dilute the leaking refrigerant before entering any room. In the case when no **refrigerant detection system** is provided, then spaces where the airflow can be limited by zoning dampers shall not be included in the determination of TA .

The minimum airflow shall be determined as:

$$Q_{\min} = 60 \times m_c / \text{LFL} \quad (\text{GG.24})$$

where

$Q_{\min}$ is the minimum **circulation airflow** circulated to the total conditioned space in m^3/h ;

m_c is the actual **refrigerant charge** for a single **refrigerating system** expressed in kg;

LFL is the **lower flammability limit** in kg/m^3 .

Compliance is checked by testing.

The **maximum refrigerant charge** based on the room area for the total conditioned space shall be in accordance with the following:

$$m_{\max} = \text{CF} \times \text{LFL} \times H \times TA \quad (\text{GG.25})$$

or

the required minimum total conditioned room area $TA_{\min}$ of the installed appliance with **refrigerant charge** m_c (kg) shall be in accordance with following:

$$TA_{\min} = m_c / (CF \times LFL \times H) \quad (GG.26)$$

where

- CF is the concentration factor with a value of 0,50;
- $m_{\max}$ is the allowable **maximum refrigerant charge** in the system in kg;
- m_c is the **refrigerant charge** in appliance in kg;
- $TA_{\min}$ is the required minimum area of the total conditioned space in m²;
- H is the height of the room = 2,2 m;
- TA is the area of the total conditioned space in m²;
- LFL is the **lower flammability limit** in kg/m³.

If TA is smaller than $TA_{\min}$, additional ventilation according to GG.8.3 shall be employed.

GG.9.2 Continuous circulation airflow

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below $Q_{\min}$, the following actions shall be taken:

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.9.3 Circulation airflow activated by a leak detection system

If a **leak detection system** is activated, the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the fan(s) of the appliance to deliver indoor airflow at or above the minimum airflow $Q_{\min}$;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space;
- fully open all zoning dampers of the appliance and energize control signals to open any external zoning dampers if applicable;
- activate additional mechanical ventilation, if required by GG.8.3.

Compliance is checked by inspection.

Building fire and smoke systems may override this function.

GG.10 Allowable charge for enhanced tightness refrigerating systems using A2L refrigerant

GG.10.1 General

Clause GG.10 is applicable to **enhanced tightness refrigerating systems** in compliance with 22.125 using **A2L refrigerants** with **refrigerant charge** of $m_1 < m_c \leq m_3$.

For individual indoor units, when tested in accordance with ISO 5151, ISO 13253, or ISO 15042

- the cooling capacity shall not exceed 35 kW at T1 conditions;
- for heating only appliances, the heating capacity shall not exceed 35 kW at H1 conditions.

The applicable measures to be taken shall be ventilation (natural or mechanical), **safety shut-off valves** and safety alarm, in conjunction with **leak detection systems** as specified in GG.10.2. A safety alarm alone shall not be considered as an appropriate measure where occupants are restricted in their movement (see Clause GG.13).

NOTE Clause GG.10 assumes a leak rate of not more than 10 kg per hour.

GG.10.2 Required measures for allowable refrigerant charge

GG.10.2.1 General

For appliances where the **refrigerant charge** does not exceed **maximum refrigerant charge** in GG.10.3.1, no additional measures are required.

GG.10.2.2 Spaces except lowest underground floor of the building

For appliances with release height, h_0 , as determined in Clause GG.2, equal to or greater than 1,8 m or with integral **circulation airflow** (see GG.10.4), where the **refrigerant charge** does not exceed **maximum refrigerant charge** in GG.10.3.2, no additional measures are required.

For appliances without integral **circulation airflow** and having release height, h_0 , less than 1,8 m, where the **refrigerant charge** exceeds the **maximum refrigerant charge** in GG.10.3.1, but is less than or equal to the **maximum refrigerant charge** in GG.10.3.2, one additional measure shall be taken in accordance with Clause GG.11, Clause GG.12 or Clause GG.13.

Where the **refrigerant charge** exceeds the **maximum refrigerant charge** in GG.10.3.2, a safety alarm shall be employed in accordance with Clause GG.13, and one additional measure shall be taken in accordance with Clause GG.11 or Clause GG.12.

GG.10.2.3 Lowest underground floor of the building

For appliances without integral **circulation airflow** and having release height, h_0 , as determined in Clause GG.2, less than 1,8 m, where the **refrigerant charge** exceeds the **maximum refrigerant charge** in GG.10.3.1, but is less than or equal to the **maximum refrigerant charge** in GG.10.3.2, a safety alarm shall be employed in accordance with Clause GG.13, and one additional measure shall be taken in accordance with Clause GG.11 or Clause GG.12.

For appliances with release height, h_0 , equal to or greater than 1,8 m or with integral **circulation airflow** (see GG.10.4), where the **refrigerant charge** exceeds the **maximum refrigerant charge** in GG.10.3.1, but is less than or equal to the **maximum refrigerant charge** in GG.10.3.2, one additional measure shall be taken in accordance with Clause GG.11, Clause GG.12 or Clause GG.13.

The **refrigerant charge** shall not exceed the **maximum refrigerant charge** in GG.10.3.2.

GG.10.3 Maximum refrigerant charge

GG.10.3.1 Maximum refrigerant charge limit A

The **maximum refrigerant charge** $m_{\max}$ in a room and the minimum room area $A_{\min}$ of the installed appliance with **refrigerant charge** m_c shall be in accordance with the following:

$$m_{\max} = CF \times LFL \times H_r \times A \quad (\text{GG.27})$$

$$A_{\min} = m_c / (CF \times LFL \times H_r) \quad (\text{GG.28})$$

where

CF is the concentration factor with a value of 0,50;

$m_{\max}$ is the **maximum refrigerant charge** in kg;

m_c is the total **refrigerant charge** in the **refrigerating system** in kg;

LFL is the **lower flammability limit** in kg/m³;

H_r is the effective height of the indoor unit in m;

A is the room floor area in m²;

$A_{\min}$ is the required minimum room area in m².

The effective height, H_r , of the unit is determined as follows:

- Where the release height, h_0 , as determined in Clause GG.2 is equal to or greater than 1,8 m or the appliance is with integral **circulation airflow**, the effective height, H_r , is the room height in m but not more than 2,2 m unless h_0 is higher than 2,2 m.
- In all other cases, the effective height, H_r , is the release height, h_0 , as determined in Clause GG.2.

For room areas exceeding 250 m², $m_{\max}$ shall be calculated with a room area (A) of 250 m².

GG.10.3.2 Maximum refrigerant charge limit B

The **maximum refrigerant charge**, $m_{\max}$, in a room and the minimum room area, $A_{\min}$, of the installed appliance with **refrigerant charge**, m_c , shall be in accordance with the following:

$$m_{\max} = CF \times LFL \times H_r \times A \quad (\text{GG.29})$$

$$A_{\min} = m_c / (CF \times LFL \times H_r) \quad (\text{GG.30})$$

where

CF is the concentration factor with a value of 0,75;

$m_{\max}$ is the **maximum refrigerant charge** in kg;

m_c is the total **refrigerant charge** in the **refrigerating system** in kg;

- LFL is the **lower flammability limit** in kg/m³;
 H_r is the effective height of the indoor unit in m;
 A is the room floor area in m²;
 $A_{\min}$ is the required minimum room area in m².

The effective height, H_r , of the unit is determined as follows:

- Where the release height, h_0 , as determined in Clause GG.2, is equal to or greater than 1,8 m or the appliance is with integral **circulation airflow**, the effective height, H_r , is the room height in m but not more than 2,2 m unless h_0 is higher than 2,2 m.
- In all other cases, the effective height, H_r , is the release height, h_0 , as determined in Clause GG.2.

For room areas exceeding 250 m², $m_{\max}$ shall be calculated with a room area (A) of 250 m².

GG.10.4 Requirement for units with integral circulation airflow

GG.10.4.1 General

The minimum air velocity and minimum airflow shall be as follows:

- Minimum airflow = 240 m³/h.
- There is no minimum **circulation airflow** velocity requirement for downwards airflow.
- Minimum air velocity for upwards airflow:

$$v_{\min} = (-4,0 \times 10^{-5} \times M^2 + 0,0108 \times M + 1,42) / \sin \varphi \quad (\text{GG.31})$$

where

- $v_{\min}$ is the minimum air velocity in m/s;
 M is the molar mass in kg/kmol;
 φ is the airflow angle above horizontal in degrees; an angle below 15° is considered to be 15°.
- The unit air velocity (v) shall be calculated as airflow divided by the nominal face area of the outlet. The grille area shall not be deducted.

NOTE The formula is based on appliances with a refrigerant release on floor level, which represents the most stringent situation.

As an alternative, for airflow angles between 15° and 90°, the minimum air velocity ($v_{\min}$) can be determined by linear interpolation of the values included in Table GG.5.

Compliance is checked by testing.

Operation of **circulation airflow** shall comply with either GG.10.4.2 or GG.10.4.3.

GG.10.4.2 Continuous circulation airflow

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below $Q_{\min}$, the following actions shall be taken:

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.10.4.3 Circulation airflow activated by a leak detection system

If a **leak detection system** is activated, the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the fan(s) of the appliance to deliver indoor airflow at or above the minimum airflow $Q_{\min}$;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.11 Ventilation for enhanced tightness refrigerating systems using A2L refrigerants

GG.11.1 General

Ventilation shall be made to a place where sufficient air is available to dilute the leaked refrigerant, such as outdoors or a large space.

Where ventilation is to an indoor space, the total area of that space and the space in which the appliance is installed shall have a total room area not less than $A_{\min}$ according to the Formula (GG.32). If the opening area in GG.11.2 is not large enough, the measure of GG.11.3 shall be taken with ventilation to the outdoors.

$$A_{\min} = m_c / (CF \times LFL \times H_r) \quad (\text{GG.32})$$

where

CF is the concentration factor with a value of 0,50;

m_c is the total **refrigerant charge** in the **refrigerating system** in kg;

LFL is the **lower flammability limit** in kg/m³;

H_r is the effective height of the indoor unit in m;

$A_{\min}$ is the required minimum room area in m².

The effective height, H_r , of the unit is determined as follows:

- where the release height, h_0 , as determined in Clause GG.2, is equal to or greater than 1,8 m or the appliance is with integral **circulation airflow**, the effective height, H_r , is the room height in m but not more than 2,2 m unless h_0 is higher than 2,2 m;
- in all other cases, the effective height, H_r , is the release height, h_0 , as determined in Clause GG.2.

GG.11.2 Natural ventilation

If natural ventilation is applied, the following shall be met:

- Openings for natural ventilation shall comply with GG.1.4.
- Natural ventilation to outdoors is not allowed below ground level.
- Natural ventilation from an occupied space shall not be made to outdoors.

NOTE User can block the natural ventilation to the outside if it is cold outside.

The minimum opening area for natural ventilation ($A_{nv,min}$) to an indoor space shall be:

$$A_{nv,min} = \frac{1}{720 \times LFL} \times \sqrt{\frac{M}{LFL \times (M - 29)}} \quad (GG.33)$$

where

$A_{nv,min}$ is the minimum required natural ventilation opening area in m²;

M is the molar mass in kg/kmol;

LFL is the **lower flammability limit** expressed in kg/m³;

720 is the coefficient resulting from calculating all the constants used to establish the formula;

29 is the average molar mass of air in kg/kmol.

The minimum opening area for natural ventilation ($A_{nv,min}$) to an outdoor space shall be:

$$A_{nv,min} = 0,14 \times \sqrt{m_c \times \frac{0,04}{LFL}} \quad (GG.34)$$

where

m_c is the **refrigerant charge** of a system in kg;

LFL is the **lower flammability limit** in kg/m³;

$A_{nv,min}$ is the minimum required natural ventilation opening area in m²;

0,14 is a constant derived from the gravity acceleration, flow coefficient, etc.;

0,04 is the conversion constant from hydrocarbon to another LFL.

GG.11.3 Mechanical ventilation

GG.11.3.1 Operation of mechanical ventilation

Mechanical ventilation shall be operated continuously or shall be switched on by a **leak detection system**.

Operation shall be according to GG.8.3.1.

GG.11.3.2 Required airflow

For $(Q_{\min} \times 0,25 \times \text{LFL})/10 < 1$, the airflow of the mechanical ventilation shall be at least the quantity that satisfies the following formula:

$$m_c = \frac{10 \times V}{Q_{\min}} \ln \left(1 - \frac{Q_{\min} \times 0,25 \times \text{LFL}}{10} \right) \quad (\text{GG.35})$$

For $(Q_{\min} \times 0,25 \times \text{LFL})/10 \geq 1$, the airflow shall be determined according to the following formula:

$$Q_{\min} = \frac{10}{0,25 \times \text{LFL}} \quad (\text{GG.36})$$

where

m_c is the **refrigerant charge**, expressed in kg;

V is the room volume in m^3 ;

10 is the expected maximum leak rate in kg/h;

$Q_{\min}$ is the ventilation airflow in m^3/h ;

LFL is the **lower flammability limit** in kg/m^3 .

Losses caused by ducts or other components in the air stream shall be considered.

GG.11.3.3 Mechanical ventilation openings

The upper edge of the air extraction opening from the room shall be located at a height equal to or below the refrigerant release point.

The mechanical ventilation air extracted from the space shall be positioned relative to the mechanical ventilation air intake openings such that the makeup air will mix with the leaked refrigerant.

Where **circulation airflow** according to GG.10.4 is not provided, the openings shall comply with GG.8.3.3.

GG.12 Safety shut-off valves for enhanced tightness refrigerating systems using A2L refrigerants

Safety shut-off valves shall be positioned to enable access for maintenance by an authorized person.

For appliances which are not on the lowest underground floor, where the release height, h_0 , as determined in Clause GG.2 is equal to or greater than 1,8 m or the appliance is with integral **circulation airflow**, the **releasable charge** as determined by Annex QQ shall be limited to:

$$m_{rl} < CF \times LFL \times H_r \times A \quad (\text{GG.37})$$

where

CF is the concentration factor with a value of 0,75;

m_{rl} is the **releasable charge** in kg;

LFL is the **lower flammability limit** in kg/m³;

H_r is the effective height of the indoor unit as determined in GG.10.3 in m;

A is the room floor area in m².

For all other appliances, the **releasable charge** as determined by Annex QQ shall be limited to:

$$m_{rl} < CF \times LFL \times H_r \times A \quad (\text{GG.38})$$

where

CF is the concentration factor with a value of 0,50;

m_{rl} is the **releasable charge** in kg;

LFL is the **lower flammability limit** in kg/m³;

H_r is the effective height of the indoor unit as determined in GG.10.3 in m;

A is the room floor area in m².

GG.13 Safety alarms for enhanced tightness refrigerating systems using A2L refrigerants

GG.13.1 General

If a safety alarm is employed to warn of a leak in the occupied space, the safety alarm shall warn of a refrigerant leak in accordance with GG.13.2. The safety alarm shall be turned on by the signal from the **leak detection system**. The safety alarm shall also alert an authorized person to take appropriate action.

GG.13.2 Safety alarm system warning

GG.13.2.1 General

The safety alarm system shall warn both audibly and visibly, such as both a loud (15 dBA above the background level) buzzer and a flashing light.

GG.13.2.2 Safety alarm for general occupancy

At least one safety alarm inside the occupied space shall be installed. For the occupancy listed below, the safety alarm system shall also warn at a supervised location, such as the night porter's location, as well as the occupied space:

- rooms, parts of buildings, building where sleeping facilities are provided;
- rooms, parts of buildings, building where people are restricted in their movement;
- rooms, parts of buildings, building where an uncontrolled number of people are present; or
- rooms, parts of buildings, building to which any person has access without being personally acquainted with the necessary safety precautions.

Table GG.5 – Minimum air velocity

Minimum air velocity							
$v_{\min}$ (m/s)							
h_a (m)	M	Airflow angle above horizontal φ (degrees)					
		15	30	45	60	75	90
< 0,3	50	7,08	3,67	2,59	2,12	1,90	1,83
	60	7,40	3,83	2,71	2,21	1,98	1,92
	70	7,62	3,94	2,79	2,28	2,04	1,97
	80	7,78	4,03	2,85	2,32	2,08	2,01
	90	7,90	4,09	2,89	2,36	2,12	2,04
	100	8,00	4,14	2,93	2,39	2,14	2,07
	110	8,07	4,18	2,96	2,41	2,16	2,09
	120	8,14	4,21	2,98	2,43	2,18	2,11
< 0,60	50	6,47	3,35	2,37	1,93	1,73	1,67
	60	6,76	3,50	2,47	2,02	1,81	1,75
	70	6,96	3,60	2,55	2,08	1,86	1,80
	80	7,10	3,68	2,60	2,12	1,90	1,84
	90	7,21	3,73	2,64	2,16	1,93	1,87
	100	7,30	3,78	2,67	2,18	1,96	1,89
	110	7,37	3,82	2,70	2,20	1,97	1,91
	120	7,43	3,85	2,72	2,22	1,99	1,92
< 0,90	50	5,78	2,99	2,12	1,73	1,55	1,50
	60	6,04	3,13	2,21	1,81	1,62	1,56
	70	6,22	3,22	2,28	1,86	1,67	1,61
	80	6,35	3,29	2,32	1,90	1,70	1,64
	90	6,45	3,34	2,36	1,93	1,73	1,67
	100	6,53	3,38	2,39	1,95	1,75	1,69
	110	6,59	3,41	2,41	1,97	1,77	1,71
	120	6,64	3,44	2,43	1,99	1,78	1,72

Minimum air velocity							
$v_{\min}$ (m/s)							
h_a (m)	M	Airflow angle above horizontal φ (degrees)					
		15	30	45	60	75	90
< 1,20	50	5,01	2,59	1,83	1,50	1,34	1,30
	60	5,23	2,71	1,92	1,56	1,40	1,35
	70	5,39	2,79	1,97	1,61	1,44	1,39
	80	5,50	2,85	2,01	1,64	1,47	1,42
	90	5,59	2,89	2,04	1,67	1,50	1,45
	100	5,65	2,93	2,07	1,69	1,52	1,46
	110	5,71	2,96	2,09	1,71	1,53	1,48
	120	5,75	2,98	2,11	1,72	1,54	1,49
< 1,50	50	4,09	2,12	1,50	1,22	1,10	1,06
	60	4,27	2,21	1,56	1,28	1,15	1,11
	70	4,40	2,28	1,61	1,31	1,18	1,14
	80	4,49	2,32	1,64	1,34	1,20	1,16
	90	4,56	2,36	1,67	1,36	1,22	1,18
	100	4,62	2,39	1,69	1,38	1,24	1,19
	110	4,66	2,41	1,71	1,39	1,25	1,21
	120	4,70	2,43	1,72	1,40	1,26	1,22
< 1,80	50	2,89	1,50	1,06	0,86	0,77	0,75
	60	3,02	1,56	1,11	0,90	0,81	0,78
	70	3,11	1,61	1,14	0,93	0,83	0,81
	80	3,18	1,64	1,16	0,95	0,85	0,82
	90	3,23	1,67	1,18	0,96	0,86	0,83
	100	3,26	1,69	1,19	0,98	0,87	0,84
	110	3,30	1,71	1,21	0,99	0,88	0,85
	120	3,32	1,72	1,22	0,99	0,89	0,86

h_a is the air delivery height in the upper side in m.

GG.14 Allowable charge for enhanced tightness refrigerating systems using A2 or A3 refrigerant

GG.14.1 General

Clause GG.14 is applicable to **enhanced tightness refrigerating systems** in compliance with 22.125 using A2 or A3 refrigerants with **refrigerant charge** of $m_1 < m_c \leq m_2$.

GG.14.2 Requirement for enhanced tightness units without integral circulation airflow

For **enhanced tightness refrigerating systems**, the **maximum refrigerant charge** in a room shall be in accordance with the following:

$$m_{\max} = CF \times LFL \times A \times h_0 \quad (\text{GG.39})$$

or the required minimum room area $A_{\min}$ of installed appliance with **refrigerant charge** m_c shall be in accordance with the following:

$$A_{\min} = m_c / (CF \times LFL \times h_0) \quad (\text{GG.40})$$

where

CF is a concentration factor with a value of 0,35;

$m_{\max}$ is the allowable **maximum refrigerant charge** in the system in kg;

m_c is the actual **refrigerant charge** in the system in kg;

$A_{\min}$ is the required minimum room area in m²;

h_0 is the release height, the vertical distance in metres from the floor to the point of release when the appliance is installed (see Figure GG.3) according to GG.2.1 but not less than 0,6 m and not to exceed 2,2 m;

A is the room area in m²;

LFL is the **lower flammability limit**, in kg/m³.

GG.14.3 Requirement for enhanced tightness units with integral circulation airflow

GG.14.3.1 General

When the fan integrated into an appliance is continuously operated or operation is initiated by a **leak detection system** with sufficient airflow rate, the **maximum refrigerant charge** can be increased or the minimum room area can be reduced according to the following.

For **enhanced tightness refrigerating systems**, the **maximum refrigerant charge** in a room shall be in accordance with the following:

$$m_{\max} = CF \times LFL \times A \times 2,2 \quad (\text{GG.41})$$

or the required minimum room area $A_{\min}$ of installed appliance with **refrigerant charge** m_c shall be in accordance with the following:

$$A_{\min} = m_c / (CF \times LFL \times 2,2) \quad (\text{GG.42})$$

where

- $m_{\max}$ is the allowable **maximum refrigerant charge** in the system in kg;
- CF is a concentration factor specified by the manufacturer and not exceeding 0,5. CF shall be the same value as used in in Formula (GG.43) for calculating $Q_{\min}$;
- m_c is the actual **refrigerant charge** in the system in kg;
- $A_{\min}$ is the required minimum room area in m²;
- 2,2 is the room height in m;
- A is the room area in m²;
- LFL is the **lower flammability limit**, in kg/m³.

NOTE 1 A lower value of CF can be specified to give a lower airflow requirement, and it results in a higher $A_{\min}$ and lower $m_{\max}$.

The minimum **circulation airflow** shall be determined as:

$$Q_{\min} = 3\,600 \frac{5Y \sqrt{A_o} \dot{m}_{\text{leak}}^{3/4}}{h_o^{1/4} [\text{LFL} \times (1 - \text{CF})]^{5/8}} \quad (\text{GG.43})$$

where

- $Q_{\min}$ is the required airflow volume in m³/h;
- 3 600 is a constant to convert m³/s to m³/h;
- A_o is the airflow discharge area of the appliance in m². The value is the nominal face area of the outlet. The grille area shall not be deducted;
- Y is a constant, if there are leak sources outside the unit $Y = 1,5$, otherwise $Y = 1$;
- $\dot{m}_{\text{leak}}$ is the refrigerant leak rate as determined in Table GG.6 in kg/s;
- h_o is the release height, the vertical distance in metres from the floor to the point of release when the appliance is installed (see Figure GG.3) according to GG.2.1 but not less than 0,6 m and not to exceed 2,2 m;
- LFL is the **lower flammability limit** in kg/m³;
- CF is a concentration factor not exceeding 0,5. The value shall be the value as used in Formula (GG.41) and Formula (GG.42) for calculating $m_{\max}$ and $A_{\min}$.

Table GG.6 – Refrigerant leak rate ($\dot{m}_{\text{leak}}$)

Refrigerant	Refrigerant leak rate kg/s
R152a	0,000 92
RE170	0,000 74
R290	0,001 12
R600	0,000 34
R600a	0,000 48
R1270	0,001 35

NOTE The values were calculated using Formulae (GG.44) and (GG.45) using properties from REFPROP 9.1². Properties of selected refrigerants are also available in ISO 17584.

For refrigerants not listed in Table GG.6, leak mass flow rate ($\dot{m}_{\text{leak}}$) is calculated from:

$$\dot{m}_{\text{leak}} = (167/432) 10^{-6} \dot{M}_s \quad (\text{GG.44})$$

where

$\dot{m}_{\text{leak}}$ is the assumed leak rate from the system in kg/s;

167 is a reference leak mass flow rate in g/min;

432 is a coefficient;

$\dot{M}_s$ is the choked flow mass flux in kg/m²s.

The choked flow mass flux, $\dot{M}_s$, is:

$$\dot{M}_s = 0,61 \times \sqrt{k \rho_0 p_0 \left(\frac{2}{k+1} \right)^{\frac{k+1}{k-1}}} \quad (\text{GG.45})$$

where

0,61 is the discharge coefficient;

k is the ratio of specific heats of refrigerant vapour;

ρ_0 is the density of saturated refrigerant vapour at 45 °C in kg/m³ at the system pressure p_0 ;

p_0 is the pressure in the system at 45 °C in Pa.

NOTE 2 REFPROP³ is an example of a commercial product providing values for k . Properties of selected refrigerants are also available in ISO 17584.

² REFPROP 9.1 is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of this product.

³ REFPROP is an example of a suitable product available commercially. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC of this product.

Compliance is checked by testing.

Operation of **circulation airflow** shall comply with either GG.14.3.2 or GG.14.3.3.

GG.14.3.2 Continuous circulation airflow

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be monitored continuously. Within 10 s in the event that the airflow is reduced below $Q_{\min}$, the following actions shall be taken:

- warn user that airflow is reduced;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

GG.14.3.3 Circulation airflow activated by a leak detection system

If a **leak detection system** is activated, the following actions shall be taken and continued for at least 5 min after the **leak detection system** has reset:

- energize the fan(s) of the appliance to deliver indoor airflow at or above the minimum airflow $Q_{\min}$;
- disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.

Compliance is checked by inspection.

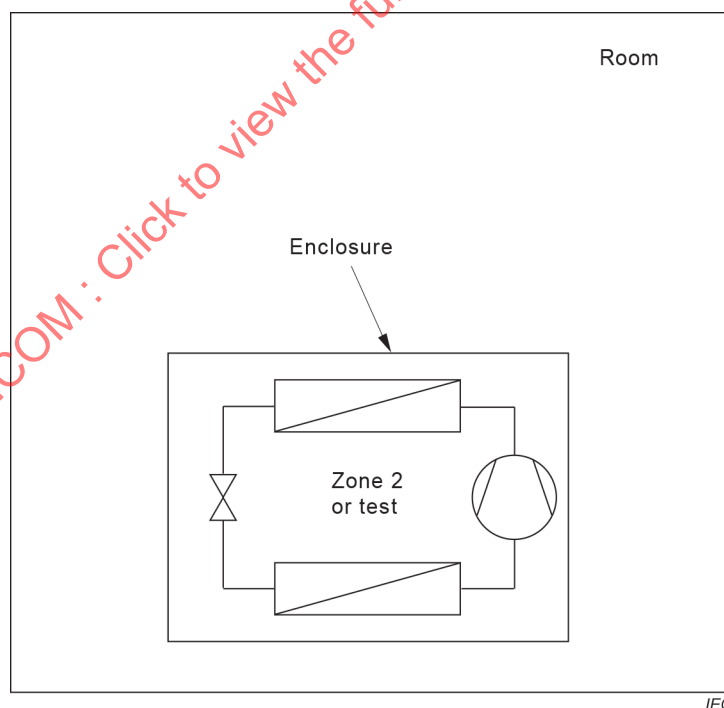


Figure GG.1 – Unventilated area

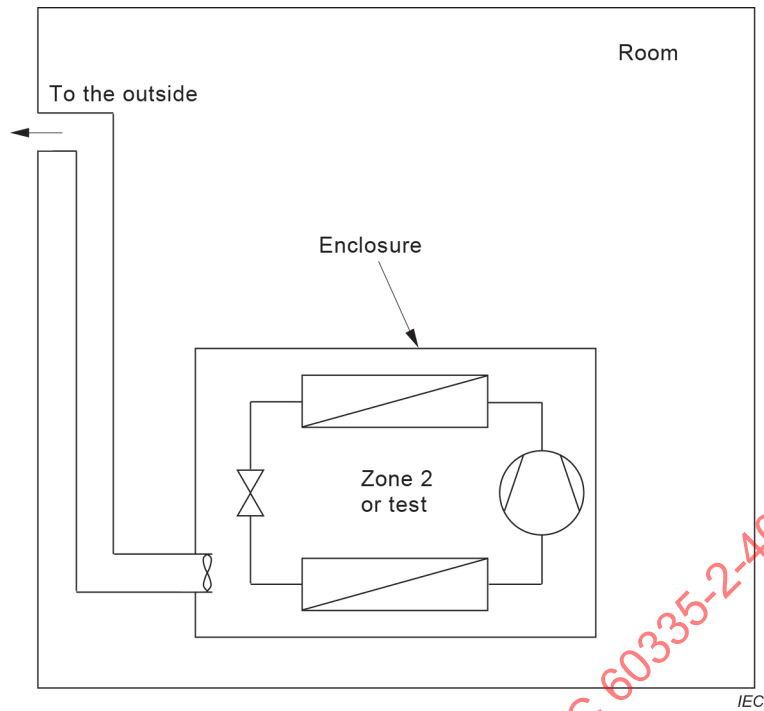


Figure GG.2 – Mechanical ventilation

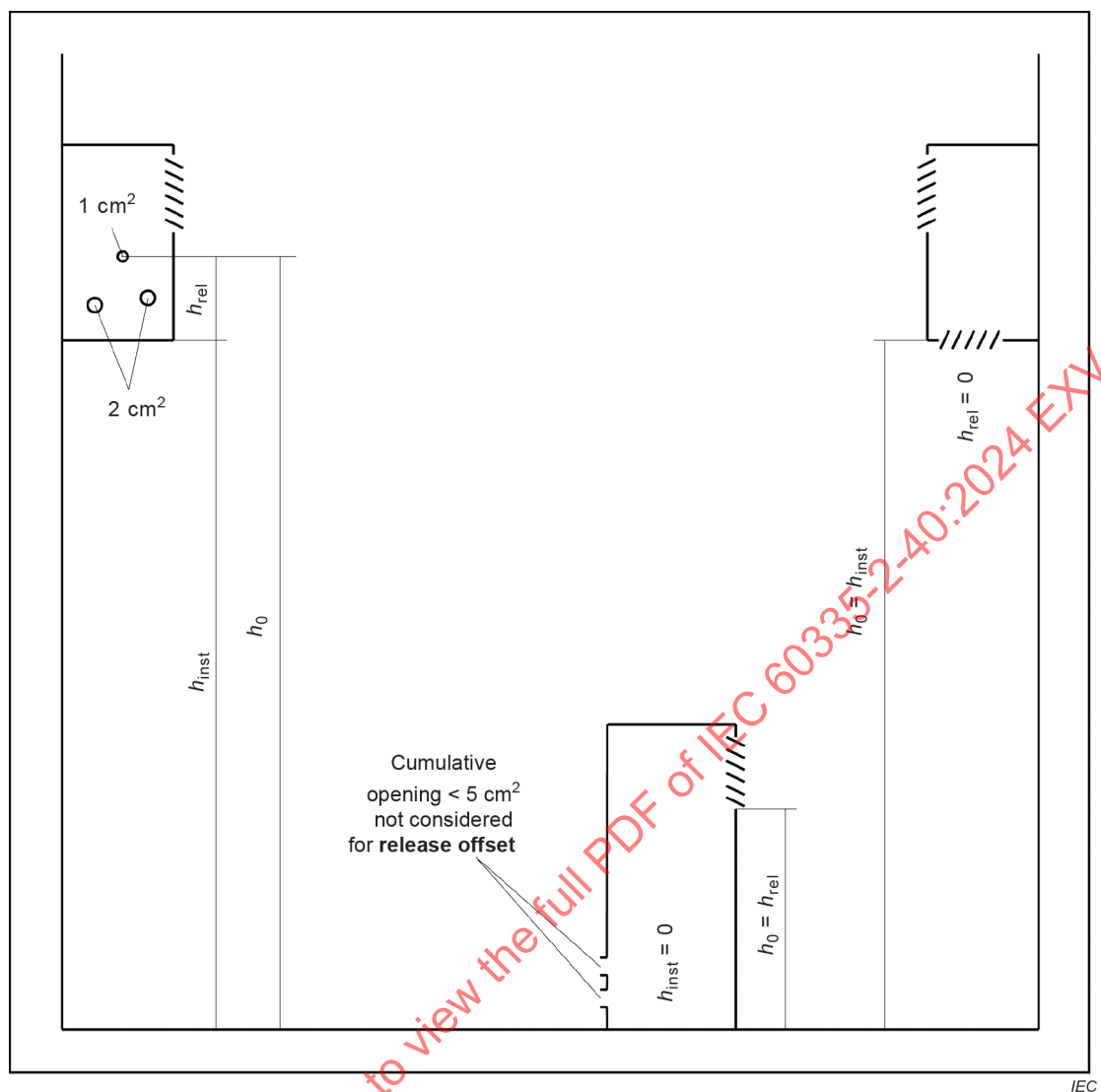
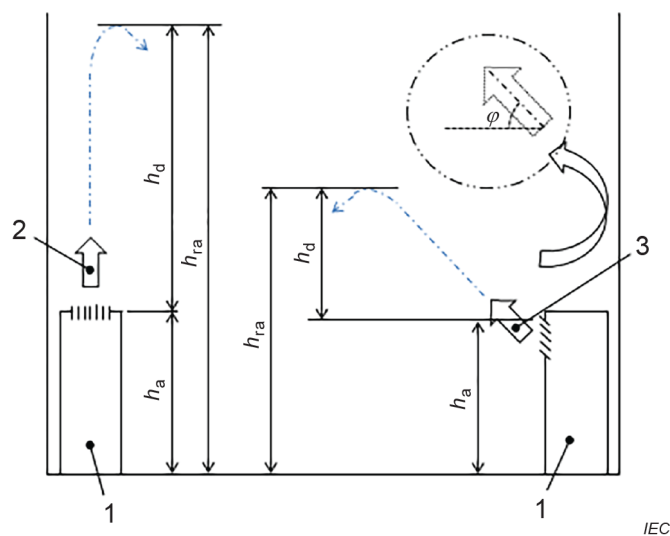


Figure GG.3 – Relevant heights h_{inst} , h_0 and h_{rel} for calculation of A_{min} and m_{max}



Key

- 1 appliance
- 2 airflow direction: Upwards (vertical $\varphi = 90^\circ$)
- 3 airflow direction: Upwards

Figure GG.4 – Airflow direction

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex HH (informative)

Competence of service personnel

HH.1 General

Information on procedures additional to the usual information for refrigerating appliance installation, repair, maintenance and decommission procedures is required when an appliance with **flammable refrigerants** is affected.

The training in these procedures is carried out by training organizations or manufacturers that are competent to teach the relevant national competency standards that can be set in legislation.

The achieved competence should be documented by a certificate.

HH.2 Information and training

HH.2.1 The training should include the substance of the following:

HH.2.2 Information about the explosion potential of **flammable refrigerants** to show that flammables can be dangerous when handled without care.

HH.2.3 Information about potential ignition sources, especially those that are not obvious, such as lighters, light switches, vacuum cleaners, electric heaters.

HH.2.4 Information about the different safety concepts:

- Unventilated (see Clause GG.2): Safety of the appliance does not depend on ventilation of the housing. Switching off the appliance or opening of the housing has no significant effect on safety. Nevertheless, it is possible that leaking refrigerant can accumulate inside the enclosure and flammable atmosphere will be released when the enclosure is opened.
- Ventilated enclosure (see Clause GG.4): Safety of the appliance depends on ventilation of the housing. Switching off the appliance or opening of the enclosure has a significant effect on safety. Care should be taken to ensure sufficient ventilation before switching off.
- Ventilated room (see Clause GG.5): Safety of the appliance depends on the ventilation of the room. Switching off the appliance or opening of the housing has no significant effect on safety. The ventilation of the room shall not be switched off during repair procedures.

HH.2.5 Information about refrigerant detectors:

- principle of function, including influences on the operation;
- procedures for how to repair, check or replace a refrigerant detector or parts of it in a safe way;
- procedures for how to disable a refrigerant detector in case of repair work on the refrigerant carrying parts.

HH.2.6 Information about the correct working procedures:

a) Commissioning

- Ensure that the floor area is sufficient for the **refrigerant charge** or that the ventilation duct is assembled in a correct manner.
- Connect the pipes and carry out a leak test before charging with refrigerant.
- Check safety equipment before putting into service.

b) Maintenance

- Portable equipment shall be repaired outside or in a workshop specially equipped for servicing units with **flammable refrigerants**.
- Ensure sufficient ventilation at the repair place.
- Be aware that malfunction of the equipment can be caused by refrigerant loss and that a refrigerant leak is possible.
- Discharge capacitors in a way that will not cause any spark. The standard procedure to short circuit the capacitor terminals usually creates sparks.
- Reassemble sealed enclosures accurately. If seals are worn, replace them.
- Check safety equipment before putting into service.

c) Repair

- Portable equipment shall be repaired outside or in a workshop specially equipped for servicing units with **flammable refrigerants**.
- Ensure sufficient ventilation at the repair place.
- Be aware that malfunction of the equipment can be caused by refrigerant loss and a refrigerant leak is possible.
- Discharge capacitors in a way that will not cause any spark.
- When brazing is required, the following procedures shall be carried out in the right order:
 - Remove the refrigerant and evacuate the system according to Clause DD.8.
 - Carry out a leak test before charging with refrigerant.
- Reassemble sealed enclosures accurately. If seals are worn, replace them.
- Check safety equipment before putting into service.

d) Decommissioning

- If the safety is affected when the equipment is taken out of service, the **refrigerant charge** shall be removed before decommissioning.
- Ensure sufficient ventilation at the equipment location.
- Be aware that malfunction of the equipment can be caused by refrigerant loss and a refrigerant leak is possible.
- Discharge capacitors in a way that will not cause any spark.
- Remove the refrigerant. If the recovery is not required by national regulations, drain the refrigerant to the outside. Take care that the drained refrigerant will not cause any danger. In doubt, one person should guard the outlet. Take special care that the drained refrigerant will not float back into the building.
- When **flammable refrigerants** except **A2L refrigerants** are used:
 - evacuate the refrigerant circuit,
 - purge the refrigerant circuit with inert gas for 5 min,
 - evacuate again,
 - fill with inert gas up to atmospheric pressure,
 - put a label on the equipment that the refrigerant is removed.

e) Disposal

- National regulations can apply.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex II

(Void)

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex JJ (normative)

Allowable openings of relays and similar components to prevent ignition of A2L refrigerants

JJ.1 General

Annex JJ is applicable to electrical components or devices of appliances using **A2L refrigerants**.

Annex JJ defines the maximum size of openings in relays and similar components that prevent flame propagation to the outside. A relay and similar components that comply with the requirements of this annex are not considered as a potential ignition source for **A2L refrigerants**.

JJ.2 Definition of the opening

The effective diameter is the equivalent diameter of a circular opening that has the same quenching effect to an opening of any shape. For conical holes, the smallest diameter shall be considered. The effective diameter of the openings of relays and similar components is defined as follows:

$$d_{\text{eff}} = 4 \times \frac{A}{S} \quad (\text{JJ.1})$$

where

- d_{eff} is the effective diameter in mm;
- A is the cross-sectional area of opening in mm²;
- S is the length of perimeter of opening in mm.

JJ.3 Determination of maximum allowable opening

Relays and similar components shall not be considered as a potential ignition source if the effective diameter, d_{eff} , of all holes is less than or equal to 7 mm and complies with the following formula:

$$d_{\text{eff}} < 22,3 \times S_u^{-1,09} \quad (\text{JJ.2})$$

where

- d_{eff} is the effective diameter in mm;
- S_u is the burning velocity in cm/s.

Alternatively, a type test can be used to determine if relays and similar components are not a potential ignition source. This type test shall show that there is no propagation of a flame from any contact inside of the relay to the outside, for the concentration of the refrigerant as used for determining the maximum burning velocity. Where the type test is used, the effective diameter limit is 12 mm.

Compliance is checked by inspection or by the following test: At the position of the contact, the refrigerant shall be ignited. It shall be observed if any propagation to the outside of the relay or similar component enclosure occurs. The test shall be repeated five times on the same sample and no propagation shall occur outside the relay or similar component. The test condition should be at the highest burning velocity as specified in 22.116.

NOTE A type test conducted with a refrigerant with a higher burning velocity can be used as evidence to show compliance for a refrigerant with a lower burning velocity.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex KK (normative)

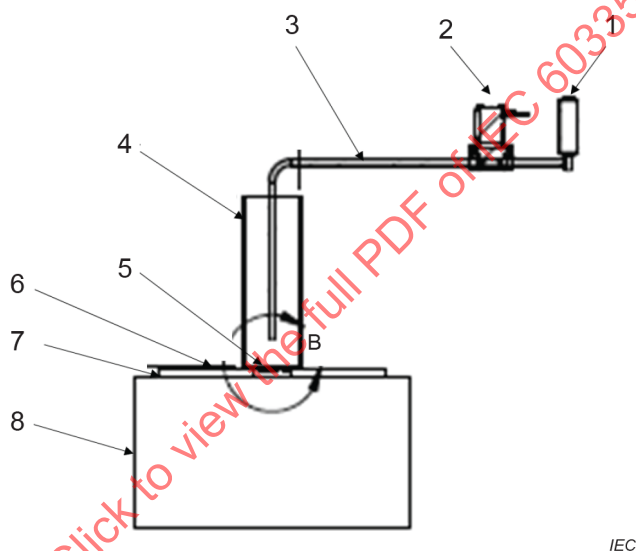
Test method for hot surface ignition temperature for A2L

KK.1 General

The **hot surface ignition temperature** of **A2L refrigerants** shall be determined according to Annex KK. The refrigerants shall be sprayed onto a horizontal flat plate surface which is set at the test temperature.

The test system consists of a hot plate, a spray tube and a chimney. Figure KK.1, Figure KK.2 and Figure KK.3 display the set-up of the test apparatus.

NOTE This method is a modification of the ASTM D6668. The ASTM test is designed for automotive fluids as a pass fail test at 815 °C. Annex KK is concerned with liquefied refrigerants and defining the maximum no ignition temperature.



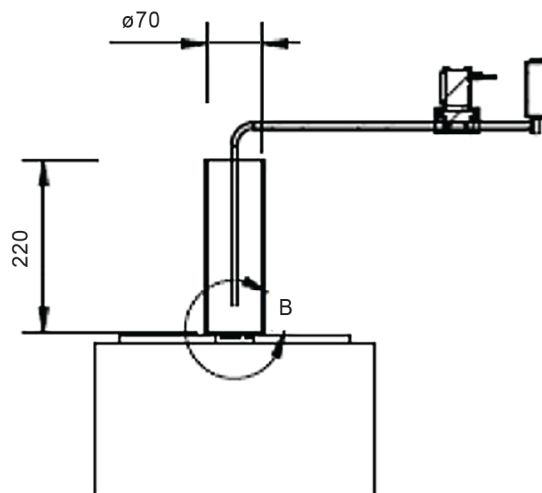
IEC

Key

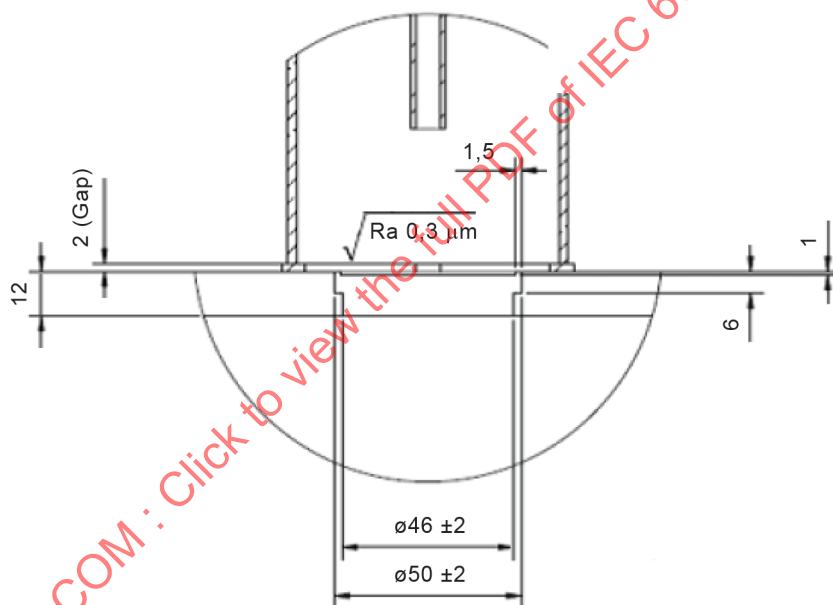
- 1 refrigerant cylinder with valve
- 2 valve
- 3 spray tube
- 4 glass cylinder
- 5 metal disc
- 6 thermocouple
- 7 insulation
- 8 hot plate

Figure KK.1 – Front view of test apparatus labels

Dimensions in millimetres



a) Front view with dimensions



b) Detail of section B

Figure KK.2 – Test apparatus with dimensions

Dimensions in millimetres

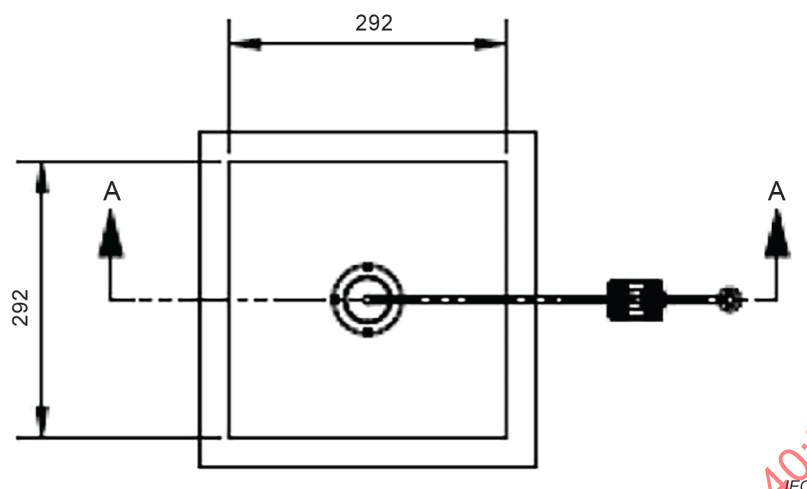


Figure KK.3 – Top view of test apparatus

KK.2 Test equipment requirements

The hot plate shall have the following characteristics. The hot plate shall consist of a flat stainless steel plate with the dimensions:

Diameter: 50 mm $\pm$ 2,0 mm

Thickness: 6 $^{+2}_{0}$ mm

Surface texture: ISO 1302

The hot plate shall be positioned horizontally. The heaters shall provide uniform heating of the plate. All surfaces other than the test surface should be thermally insulated using ceramic fibre board capable to withstand 815 °C. This insulation shall be such that vapours cannot be ignited by other than the hot plate top surface.

Spray system shall consist of a liquid supply, two valves (trap liquid volume of 1,0 cm³ $\pm$ 0,2 cm³), tubing for directing the spray. The spray tube from valve to the end shall have the following dimensions:

Length: 250 mm $\pm$ 5,0 mm

Outer diameter: $\leq$ 4 mm

Inner diameter: 1,6 mm $\pm$ 0,1 mm

Use a type K thermocouple with the individual wires spot welded on opposite sides of the centre of the upper surface of the hot plate.

A borosilicate or quartz glass chimney shall be 230 mm $\pm$ 10 mm long and have a 70 mm $\pm$ 10 mm inner diameter. The chimney shall be supported so that it is vertically mounted and has a gap of 2,5 mm $\pm$ 0,2 mm between its bottom edge and the top of the insulation.

KK.3 Procedure

The ambient conditions of the test shall be set at 23 °C $\pm$ 3 °C and 50 % RH $\pm$ 5 % RH. The chimney and hot plate establish a constant air velocity during the test. This airflow dilutes the vapours so that an optimum (near stoichiometric) concentration for ignition develops over the hot surface.

The test shall be performed in a laboratory fume hood. The test apparatus including the chimney top shall be located in the laminar flow region of the laboratory fume hood so the chimney flow is not disturbed.

The end of the spray refrigerant line shall be placed $40 \text{ mm} \pm 10 \text{ mm}$ above the hot plate and shall point to the centre of the hot plate. The tube shall be perpendicular to the horizontal plate.

Operating steps:

- a) The hot plate shall be heated until a steady test temperature is maintained for 5 min. The plate temperature shall be kept within $\pm 15^\circ\text{C}$ of the set-point during the test.
- b) Refrigerant used for the test shall be the nominal composition (NC) in accordance with ISO 817. Refrigerant from the liquid phase shall be trapped between valve 1 and valve 2. Open valve C to spray the liquid refrigerant onto the centre of the hot plate.
- c) Observe and record if ignition (flames) occurs or does not occur within 3 min after release.

NOTE Ignition is considered as being within the chimney above the plate.

Care shall be taken to avoid vapours getting under the insulation, any ignition outside of the chimney is due to ignition on surfaces hotter than the test surface.

- d) A minimum of 5 min of ventilation shall be allowed between runs to clear out reaction products and residual refrigerant.
- e) Perform a minimum of 5 repetitions trials at each temperature being tested.
- f) The temperature of the hot plate shall be set at 800°C . If ignition occurs, then the plate temperature is to be reduced in increments of 20°C until no ignition occurs in five trials. This temperature is to be recorded as the **hot surface ignition temperature**.

KK.4 Test report

The results shall be recorded in a test report. The report shall include all the information necessary for the interpretation of the test and all information required by the method used. The report shall include:

- documentation with the sample identity and composition,
- temperature where ignition did not occur and where ignition did occur if applicable.

The reported **hot surface ignition temperature** shall be the highest temperature with no ignition in five trials.

Annex LL

(Void)

NOTE Annex LL has been replaced by IEC TS 63542:2024.

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex MM (normative)

Refrigerant sensor location confirmation test

MM.1 General

This test is applicable to appliances with **refrigerant detection systems** other than remote detection.

The purpose of this test is to demonstrate that the **refrigerant sensor(s)** of the **refrigerant detection system(s)**, where required, will adequately detect refrigerant, in the event of a leak when installed in the location specified by the manufacturer. Compliance will be determined by measurement of the refrigerant concentration in the location of the **refrigerant sensor**.

MM.2 Test methods

MM.2.1 General

The composition of the refrigerant used for the test shall be taken as the nominal composition as specified in Annex BB. Where **LFL** is referenced in this annex, the **LFL** shall be taken at the nominal composition as specified in Annex BB.

The following appliance **operating states** shall be tested:

- fan OFF, and
- fan ON.

During the test, the appliance is modified by introducing a simulated leak through a capillary tube. The simulated leak is applied for 1 min.

A leakage of refrigerant in the **refrigerating system** is simulated at the most unfavourable **potential leak point** as determined in Clause FF.1. An unfavourable **potential leak point** is a **potential leak point** where the path between the leakage point and the point of detection location is more distant or more obstructed. The refrigerant is injected at the most critical point and the most unfavourable direction at a temperature between 15 °C and 35 °C. The capillary tube shall discharge refrigerant into a chamber or similar device which will reduce the refrigerant velocity into the appliance or space.

Care shall be taken that the installation of the capillary tube does not unduly influence the results of the test and that the structure of the appliance does not unduly influence the results of the test.

NOTE The **potential leak point** for fan ON or fan OFF can differ.

MM.2.2 Test with fan OFF

The test shall be performed with the fan integrated into the appliance off.

The leak rate shall be maintained at $\dot{m}_{\text{leak}}$ in g/s:

$$\dot{m}_{\text{leak}} = 4 \times \text{LFL} \quad (\text{MM.1})$$

where

4 is a constant;

$\dot{m}_{\text{leak}}$ is the mass flow rate of the simulated leak in g/s, $\pm 5\%$;

LFL is the **lower flammability limit** in kg/m³.

If the minimum airflow specified by the manufacturer is not less than the minimum airflow specified in GG.2.2, Clause GG.9 or Clause GG.10, as applicable, testing in the fan ON mode is not required.

MM.2.3 Test with fan ON

If the unit has an airflow setting less than the minimum airflow rate as defined in GG.2.2 or Clause GG.9, as applicable, then the fan ON test shall be performed on the highest available airflow setting of the unit below this minimum airflow rate.

For **enhanced tightness refrigerating systems** with A2L refrigerants in compliance with 22.125, if the unit has an airflow setting less than 20/LFL in m³/h, then the fan ON test shall be performed on the highest available airflow setting below 20/LFL in m³/h.

The leak rate shall be maintained at $\dot{m}_{\text{leak}}$ in g/s:

$$\dot{m}_{\text{leak}} = CF \times LFL \times Q \times 1\,000/3\,600, \text{ but not less than } 4 \times LFL \quad (\text{MM.2})$$

where

$\dot{m}_{\text{leak}}$ is the mass flow rate of the simulated leak in g/s, $\pm 5\%$;

CF is the concentration factor with a value of 0,50;

Q is the unit airflow in m³/h;

LFL is the **lower flammability limit** in kg/m³;

1 000 is the conversion factor from kg to g;

3 600 is the conversion factor from h to s.

MM.2.4 Test set-up

The appliance shall be installed according to the instructions. Appliances that can be installed in different positions shall be tested in all positions allowed by the manufacturer. The supply and return openings shall not be covered and the manufacturer's recommended air-filters shall be installed in accordance with the instructions.

The test is conducted in a room that is draught-free and of sufficient size to conduct the test without influencing the results by accumulation of leaked refrigerant into the room during the test.

The minimum room area A_t is:

$$A_t = 1,2 \times \dot{m}_{\text{leak}} / (LFL \times h_t) \quad (\text{MM.3})$$

where

A_t is the minimum room area for the test in m^2 ;

h_t is the height from the floor to the bottom of the unit in the test set-up in metres (m);

$\dot{m}_{leak}$ is the refrigerant leak rate in g/s;

LFL is the **lower flammability limit** in kg/m^3 ;

1,2 is the conversion factor based on limiting the test room concentration to 5 % of LFL at the end of the 60 s refrigerant release at a release rate of $\dot{m}_{leak}$.

MM.2.5 Instrumentation

The instrument used for monitoring the refrigerant gas concentration shall have a fast response to the gas concentration, at least 90 % response within 10 s (time constant 4,3 s) and shall be located as close to the intended **refrigerant sensor** location as possible, but care should be taken not to unduly influence the results of the test.

NOTE An oxygen sensor can be used for monitoring.

The sampling interval shall be 10 s or less.

MM.2.6 Compliance criteria

The measured concentration of refrigerant gas at the location of the **refrigerant detection system refrigerant sensor** shall exceed the alarm set point of the **refrigerant detection system** used within 90 s from the start of the release. Where multiple **refrigerant sensors** are applied with the **refrigerant detection system**, if the concentration at any single **refrigerant sensor** location exceeds the alarm set point of the **refrigerant detection system** used within 90 s from the start of the release, the **refrigerant detection system refrigerant sensor** location shall be considered in compliance.

Annex NN (normative)

Flame arrest enclosure verification test for A2L refrigerants

NN.1 General

Annex NN is applicable to appliances using **A2L refrigerants**.

A flame arrest enclosure is a device or assembly enclosing components with electrical contacts that are made and broken, or similar devices which can become a source of ignition which will withstand an internal ignition of a **A2L refrigerant** vapour which can enter it without suffering damage and without transmission of flame from the internal ignition to an external **A2L refrigerant** vapour of the same refrigerant.

Electrical components enclosed in a flame arrest enclosure in compliance with the test procedures below shall not be considered as a source of ignition.

If all openings in the enclosure comply with Annex JJ, the enclosure is deemed to comply.

NN.2 Test method

NN.2.1 *The test shall be conducted on a single sample enclosure or the complete appliance. The test shall be conducted one time.*

NN.2.2 *Representative electrical components and related wiring as intended in the final end usage in the appliance shall be installed in the enclosure. The enclosure shall be positioned as it would be in the appliance and all construction critical to ensure non-transmission of flames shall be included.*

NN.2.3 *If panels or similar means of access are intended to be opened or removed for routine service and maintenance, the panels shall be removed or opened ten times prior to conducting the test.*

NN.2.4 *Dielectric strength tests in accordance with 16.3 shall be conducted prior to the test.*

NN.2.5 *The ambient test conditions shall be at 32 °C **dry-bulb temperature** and 27 °C **dew point temperature**.*

NN.2.6 *The enclosure shall be filled with and surrounded by a stoichiometric mixture of the intended refrigerant.*

NN.2.7 *The flammable refrigerant vapour inside the enclosure shall be ignited in the most unfavorable position. The ignition shall be provided using a 15 kV source producing a 30 mA spark across a 6,4 mm gap for $0,3 \text{ s} \pm 0,05 \text{ s}$ or equivalent. Ignition of the refrigerant inside the enclosure shall be confirmed visually or by any other method.*

NN.2.8 *Dielectric strength tests in accordance with 16.3 shall be conducted after the test.*

NN.2.9 *The enclosure shall be considered in compliance with Annex NN if all of the following conditions are met:*

- *There shall be no ignition of the refrigerant vapour outside the enclosure.*
- *There shall be no visible signs of damage outside the enclosure.*
- *The dielectric strength after the test shall be in compliance with the requirements of this standard.*
- *The enclosure shall be capable of performing all intended primary safety functions, including protection from hazardous **live parts** and ingress of water, if applicable.*

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex OO

(Void)

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

Annex PP (normative)

Leak detection system confirmation test for flammable refrigerants

PP.1 General

This test is applicable to appliances using **flammable refrigerants** with **leak detection systems** which initiate safety measures upon detection when required according to Annex GG. This test is not applicable to **refrigerant detection systems** using remote **refrigerant sensors**.

The **leak detection system** shall comply with the following:

- for **leak detection systems** using **refrigerant detection systems**, the requirements in Clause PP.2 shall apply;
- for **leak detection systems** using ultrasonic based detection systems, the requirements of Clause PP.2 shall apply;
- for **leak detection systems** using system parameter-based detection systems, the requirements of Clause PP.3 shall apply.

For the low leak rate of PP.2.2.2 and the leak rate of PP.2.2.3 and the small leak orifice of PP.3.2, the actions required by Annex GG shall be completed within 90 s of the initiation of the simulated leak.

For the high leak rate of PP.2.2.2 and the large leak orifice of PP.3.3, the actions required by Annex GG shall be completed within 30 s of the initiation of the simulated leak. For appliances where the release height h_0 as determined in Clause GG.2 is less than 1 m, the actions required by Annex GG shall be completed within 15 s of the initiation of the simulated leak.

EXAMPLE For **circulation airflow** (according to GG.2.3.1 or GG.14.3.1 as applicable), the action is completed when the **circulation airflow** reaches Q_{min} .

PP.2 Test method for leak detection systems using refrigerant detection systems and ultrasonic based detection systems

PP.2.1 Test set-up

PP.2.1.1 General

The appliance is modified by introducing a simulated leak through an orifice or capillary tube, as appropriate. The simulated leak shall be maintained until the actions required by Annex GG are completed.

*A leak shall be simulated at the most unfavourable **potential leak point** as determined in Clause FF.1 from where the leaked refrigerant could then enter an indoor space. An unfavourable **potential leak point** is a **potential leak point** where the path between the **potential leak point** and the point of detection location is more distant or more obstructed. The test shall be conducted at the leak rates defined in PP.2.2 as applicable.*

*The composition of the refrigerant used for the test shall be taken as the nominal composition as specified in Annex BB. Where **LFL** is referenced in Annex PP, the **LFL** shall be taken at the nominal composition as specified in Annex BB.*

NOTE Sound and thermal insulation can affect the result of ultrasonic detection.

PP.2.1.2 Simulation of leak

A leakage of refrigerant in the **refrigerating system** is simulated by injecting vapour at the **potential leak points** identified in PP.2.1.1.

The refrigerant shall be released such that the pressure at the inlet to the release orifice is not less than 300 kPa (gauge) in order to achieve choked flow.

Care shall be taken that the installation of the orifice or capillary does not unduly influence the results of the test.

PP.2.1.3 Installation conditions

Appliances that can be installed in different positions shall be tested in all positions allowed by the instructions. The supply and return openings shall not be covered and the recommended air-filters shall be installed in accordance with the instructions.

PP.2.1.4 Test room

The test is conducted in a room that is of sufficient size to conduct the test without influencing the results by accumulation of leaked refrigerant into the room during the test.

The minimum room area A_t is:

$$A_t = 2,4 \times \dot{m}_{\text{leak}} / (\text{LFL} \times h_t) \quad (\text{PP.1})$$

where

A_t is the minimum room area for the test in m^2 ;

h_t is the height from the floor to the bottom of the unit in the test set-up in m;

$\dot{m}_{\text{leak}}$ is the leak rate in g/s;

LFL is the **lower flammability limit**, in kg/m^3 ;

2,4 is the conversion factor based on limiting the test room concentration to 5 % of LFL at the end of a 120 s refrigerant release at a release rate of $\dot{m}_{\text{leak}}$.

PP.2.2 Test procedure**PP.2.2.1 General**

During this test, following appliance **operating states** shall be tested:

- fan OFF, and
- fan ON.

If the actions required by Annex GG in the event of detection of a leak are **circulation airflow** and/or mechanical ventilation, and the minimum airflow specified by the manufacturer is not less than the minimum airflow specified in Annex GG, testing in the fan ON mode is not required.

PP.2.2.2 Fan OFF

The low leak rate shall be:

$$\dot{m}_{\text{leak}} = 4 \times \text{LFL} \quad (\text{PP.2})$$

where

$\dot{m}_{\text{leak}}$ is the leak rate in g/s;

4 is a constant;

LFL is the **lower flammability limit** in kg/m³.

The high leak rate shall be:

$$\dot{m}_{\text{leak}} = 4,17 \times m_c \quad (\text{PP.3})$$

where

$\dot{m}_{\text{leak}}$ is the leak rate in g/s;

4,17 is a constant;

m_c is the **refrigerant charge** in kg.

NOTE 4,17 is 1 000/240 and is based on a 4 min leak of m_c and conversion from units of kg to g.

PP.2.2.3 Fan ON

PP.2.2.3.1 General

Fan ON test shall be conducted if the actions required by Annex GG in the event of detection of a leak are **circulation airflow** and/or mechanical ventilation.

If the minimum airflow specified by the manufacturer is not less than the minimum airflow specified in Annex GG, then the fan ON test is not required.

If the minimum airflow specified is less than the minimum airflow specified in Annex GG, then the fan ON test shall be performed on the highest available airflow setting of the unit below this minimum airflow rate.

PP.2.2.3.2 Enhanced tightness refrigerating systems

For **enhanced tightness refrigerating systems** with **A2L refrigerants** in compliance with 22.125, if the unit has an airflow setting less than 20/LFL in m³/h, then the fan ON test shall be performed on the highest available airflow setting below 20/LFL in m³/h.

For **enhanced tightness refrigerating systems** with A2 and A3 refrigerants, the simulated leak mass flow shall be:

$$\dot{m}_{\text{leak}} = \left[\frac{Q h_0^{1/4} [\text{LFL} \times (1 - \text{CF})]^{5/8}}{3\,600 \times 5Y \sqrt{A_0}} \right]^{4/3} \times 10^3 \quad (\text{PP.4})$$

where

Q is the unit airflow volume in m^3/h ;

3 600 is a constant to convert h to s ;

A_o is the airflow discharge area of the appliance in m^2 . The value is the nominal face area of the outlet. The grille area shall not be deducted;

Y is a constant, if there are leak sources outside the unit $Y = 1,5$, otherwise $Y = 1$;

$\dot{m}_{\text{leak}}$ is the refrigerant leak rate in g/s ;

h_o is the release height, the vertical distance in metres from the floor to the point of release when the appliance is installed (see Figure GG.3) according to GG.2.1 but not less than 0,6 m and not to exceed 2,2 m;

LFL is the **lower flammability limit** in kg/m^3 ;

CF is a concentration factor as selected for GG.14.3.1.

PP.2.2.3.3 Non-enhanced tightness refrigerating systems

For non-enhanced tightness refrigerating systems with A2L refrigerants the leak rate shall be maintained at:

$$\dot{m}_{\text{leak}} = \text{CF} \times \text{LFL} \times Q \times 1\,000/3\,600, \text{ but not less than } 4 \times \text{LFL} \quad (\text{PP.5})$$

where

$\dot{m}_{\text{leak}}$ is the refrigerant leak rate in g/s ;

CF is the concentration factor with a value of 0,50;

LFL is the **lower flammability limit** in kg/m^3 ;

Q is the unit airflow volume in m^3/h ;

1 000 is a constant to convert kg to g ;

3 600 is a constant to convert h to s .

For non-enhanced tightness refrigerating systems with A2 and A3 refrigerants, the simulated leak mass flow shall be:

$$\dot{m}_{\text{leak}} = \frac{1000 \times Q m_c^{1/4} \text{LFL}^{3/4}}{3\,600 \times 8Y \sqrt{A_o}} \left(\frac{1 - \text{CF}}{\text{CF}^{1/4}} \right) \quad (\text{PP.6})$$

where

$\dot{m}_{\text{leak}}$ is the refrigerant leak rate in g/s ;

Q is the unit airflow volume in m^3/h ;

1 000 is a constant to convert kg to g ;

3 600 is a constant to convert h to s ;

8 is a constant;

A_o is the airflow discharge area of the appliance in m^2 . The value is the nominal face area of the outlet. The grille area shall not be deducted;

m_c is the actual **refrigerant charge** amount in the system in kg ;

LFL is the **lower flammability limit** in kg/m^3 ;

Y is a constant, if there are leak sources outside the unit $Y = 1,5$, otherwise $Y = 1$;
 CF is a concentration factor as selected in GG.2.3.1.

PP.3 Test method for leak detection systems using system parameter based detection

PP.3.1 The appliance is modified by introducing a leak orifice in the system. The leak shall continue until the actions required by Annex GG are completed.

The orifice shall be positioned at the least favourable location of the refrigerant-containing parts of the appliance intended to be located indoors. The test shall be conducted with each of the leak orifices defined in PP.3.2 and PP.3.3.

The system shall be charged with the refrigerant type and amount as stated in the instructions.

The composition of the refrigerant used for the test shall be taken as the nominal composition as specified in Annex BB. Where **LFL** is referenced in this annex, the **LFL** shall be taken at the nominal composition as specified in Annex BB.

PP.3.2 The small leak orifice to within $\pm 0,1 \text{ mm}^2$ shall be:

$$A_o = 4 \times \text{LFL} / 1,7 \quad (\text{PP.7})$$

where

A_o is the orifice area in mm^2 and shall be no less than $0,1 \text{ mm}^2$;

4 is a constant;

1,7 is a nominal mass flux in $\text{g}/(\text{s mm}^2)$;

LFL is the lower flammability limit, in kg/m^3 .

The length of the orifice bore shall be no longer than 1 mm.

PP.3.3 The large leak orifice to within $\pm 0,1 \text{ mm}^2$ shall be:

$$A_o = 4 \times m_c / 0,8 \quad (\text{PP.8})$$

where

A_o is the orifice area in mm^2 and shall be no less than $0,1 \text{ mm}^2$;

4 is a constant;

0,8 is a nominal mass flux in $\text{g}/(\text{s mm}^2)$;

m_c is the **refrigerant charge** in kg.

The length of the orifice bore shall be no longer than 1 mm.

PP.3.4 *The system shall be operated in the following operating states as appropriate:*

- a) *compressor off with indoor temperature of 27 °C and outdoor temperature of 35 °C, with indoor fan ON;*
- b) *compressor off with indoor temperature of 27 °C and outdoor temperature of 35 °C, with indoor fan OFF;*
- c) *cooling mode with*
 - *the compressor running at maximum speed at the specified temperature, and*
 - *highest outdoor air temperature and highest airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate, and*
 - *highest indoor air temperature and highest indoor fan airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate;*
- d) *heating mode with*
 - *the compressor running at maximum speed at the specified temperature, and*
 - *highest outdoor air temperature and highest airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate, and*
 - *highest indoor air temperature and highest indoor fan airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate;*

NOTE The fan can have a different maximum speed depending on the operating state and working temperature; the highest speed in that condition is relevant.

The test is for the condition where the leak orifice is positioned at the most critical location, being the one that yields the greatest time before the actions required by Annex GG are completed.

Care shall be taken that the installation of the orifice does not unduly influence the results of the test.

Annex QQ (normative)

Methods for determining releasable charge

QQ.1 General

The **releasable charge** m_{rl} shall be determined in each **operating state** in accordance with Annex QQ.

The **operating state** to be applied for a **refrigerating system** which is not a **releasable charge limited system** is unit powered in standby mode, indoor and outdoor ambient at 23 °C. The crankcase heater, if any, shall be energized.

NOTE 1 It can be necessary to bypass a **thermostat** to ensure the crankcase heater is energized.

For a **releasable charge limited system**, the test conditions of Clause QQ.6 apply.

NOTE 2 When safety shut-off valves are applied, both sides of the valve can be potential leak positions.

For **refrigerating systems** that comply with the requirements of Clause GG.10 and have **releasable charge limited systems** using **safety shut-off valves**, the **releasable charge** shall be determined by Clause QQ.2, Clause QQ.3, or Clause QQ.4.

NOTE 3 The **releasable charge** can be determined by calculation, measurement or a combination thereof, depending on the product and application. For large or complicated **refrigerating systems**, it can be impossible or impractical to execute the test of Clause QQ.2, due to the large number of configurations or when leaking of the refrigerant into the atmosphere cannot be accepted during testing.

For all other **refrigerating systems**, the **releasable charge** shall be determined by Clause QQ.2.

QQ.2 Determination of releasable charge by a simulated leak

QQ.2.1 Test set-up

The appliance shall be installed within the test facility according to the instructions.

If the appliance can be installed with additional pipework, the pipework shall be installed which results in the largest **releasable charge**.

NOTE 1 The largest **releasable charge** is typically at the largest pipe diameter and length specified by the instructions.

The **refrigerating system** shall be evacuated prior to each test and charged with the **refrigerant charge** according to the instructions.

The evacuation process should be sustained for a sufficiently long time to ensure any refrigerant absorbed in the oil has been removed.

All **potential leak points** as determined in Clause FF.1 from where leaked refrigerant could then enter an indoor space shall be considered for determining the **releasable charge**.

A leak orifice shall be installed at a location in the **refrigerating system** that would result in the greatest amount of refrigerant entering the indoor space. A valve to enable opening and closing the orifice shall be installed between the position where a leak could occur and the orifice. The distance from the position where a leak could occur to the orifice shall be less than 200 mm. The piping shall be no less than 4 mm internal diameter.

NOTE 2 It can be necessary to consider multiple locations.

The test is for the condition where the leak orifice is positioned at the most critical location, being the one that yields the greatest **releasable charge**.

For a **releasable charge limited system**, the test shall be repeated with each of the following three orifice sizes:

- small orifice size according to PP.3.2;
- medium orifice size 1,5 mm ± 0,15 mm diameter;
- large orifice size 2,5 mm ± 0,25 mm diameter.

For other **refrigerating systems**, the test shall be carried out with the large orifice size of 2,5 mm ± 0,25 mm diameter.

The length of the orifice bore shall be no longer than 1 mm.

NOTE 3 Small orifice size is based on a 15 g/min leak rate of R290 vapour at saturation pressure corresponding to 10 °C (under choked flow). It is assumed that a system leaking at this flow rate is unlikely to lead to accumulation of dangerous concentrations.

NOTE 4 Large orifice size is based on an R-290 system comprising a mass of m_2 releasing its entire charge in approximately 4 min at saturation pressure corresponding to 10 °C (under choked flow).

The **refrigerating system** shall be tested under the relevant **operating state** and under the conditions which result in the greatest amount of **refrigerant charge** being released.

QQ.2.2 Test method

The **refrigerating system** is operated according to the **operating state** of the appliance.

The test shall be repeated at least three times. The **releasable charge** m_{rl} shall be three standard deviations above the mean of the test results.

The refrigerant is released directly into a test room or directly vented to the outside, as appropriate for the test.

The appliance **refrigerating system** shall be stabilized in the **operating state** and test conditions for 30 min prior to opening the leak orifice.

For systems which are not **releasable charge limited systems**, the system shall be turned off immediately before starting the test.

The leak orifice is opened for a duration of 4 h, after which time the leak orifice valve shall be closed.

The **refrigerating system** shall then be evacuated and the refrigerant removed shall be measured.

The weight of the refrigerant removed at the end of the test is the retained mass (m_{ret}). The **releasable charge** (m_{rl}) is then determined by:

$$m_{\text{rl}} = m_{\text{c}} - m_{\text{ret}} \quad (\text{QQ.1})$$

where

m_{rl} is the **releasable charge** in kg;

m_{c} is the **refrigerant charge** in kg;

m_{ret} is the refrigerant retained in the system at the end of the leak in kg.

QQ.3 Determination of releasable charge by a simulated leak for refrigerating systems complying with Clause GG.10

QQ.3.1 General

The **releasable charge**, m_{rl} , shall be determined by the test of QQ.3.2 and QQ.3.3.

QQ.3.2 Test set-up

NOTE 1 This method is similar to Clause QQ.2, only modified to allow evaluation of systems with refrigerants that cannot be vented into atmosphere.

Install the appliance, including **safety shut-off valves**, according to the instructions, in the smallest room as specified by the instructions, with the set-up that will create the largest **releasable charge** for that room.

NOTE 2 A test set-up with indoor units with a larger inner volume can be representative for units with a smaller inner volume. A test set-up with piping with a larger inner volume can be representative for piping with a smaller inner volume.

NOTE 3 It is possible for the instructions to cover different room sizes for different set-ups; if so, each set-up will be considered separately.

The **refrigerating system** shall be evacuated prior to each test, and then charged with refrigerant equal to m_{c} , where m_{c} is the **refrigerant charge** in kg.

A calibrated leak opening shall be installed in the **refrigerating system** that would result in the greatest amount of refrigerant released in the occupied space. A valve to enable opening and closing of the calibrated leak opening shall be installed between the appliance and the calibrated leak opening. The calibrated leak shall be at the point in the circuit that has the highest saturated pressure in the indoor unit during steady state operation.

The calibrated leak opening shall vent into a volume at atmospheric pressure.

NOTE 4 The volume can be a room or a pressure vessel kept at atmospheric pressure; this is to avoid that the refrigerant is released into the atmosphere.

The calibrated opening shall be a capillary or orifice that leaks at 2,8 g/s from saturated liquid at a saturated pressure of 63 °C.

QQ.3.3 Test method

The **refrigerating system** shall operate according to the **operating state** until steady state is reached for at least 30 min, prior to opening the valve of the calibrated leak opening.

NOTE 1 The same applies for standstill condition.

The test shall be repeated at least three times and the **releasable charge** shall be two standard deviations above the mean result.

NOTE 2 The calculation of the mean value and the standard deviations apply to each **operating state** separately.

The valve to the calibrated leak opening is opened.

The **refrigerating system** shall operate normally for t_{r1} time with the calibrated leak open, where t_{r1} is the time before the leak is detected as determined in Clause QQ.5.

After the t_{r1} time, the refrigerant charge limited system shall simulate a detected leak.

NOTE 3 This can be done by any method, for example putting the refrigerant sensor in the refrigerant concentration above the alarm set point of the sensor, C_{set} .

After the **safety shut-off valves** are closed, the remaining charge m_{rm} contained in the part of the **refrigerating system** which is closed by the **safety shut-off valves** is measured.

The **releasable charge** (in kg) is:

$$m_{rl} = m_c - m_{rm} \quad (\text{QQ.2})$$

where

m_c is the **refrigerant charge** in kg;

m_{rm} is the remaining charge in kg.

QQ.4 Determination of releasable charge by calculation and test for refrigerating systems complying with Clause GG.10

QQ.4.1 General

The **releasable charge**, m_{rl} , shall be calculated as the sum of the refrigerant released in the separate stages according to the following:

$$m_{rl} = t_{r1} \times 0,002\ 8 + m_{r2} + m_{r3} \quad (\text{QQ.3})$$

where

t_{r1} is the time before the leak is detected as determined in Clause QQ.5 in s;

m_{r2} is the charge released between detection and closing the **safety shut-off valves** as determined in QQ.4.2 in kg;

m_{r3} is the refrigerant released after closing the **safety shut-off valves** in part of the system that can leak into the occupied space as determined in QQ.4.3 in kg;

0,002 8 is the assumed leak rate in kg/s.

NOTE The **releasable charge** considers the following: Refrigerant release before the leak is detected, refrigerant release between the detection and closing of the **safety shut-off valves** and refrigerant release afterwards.

QQ.4.2 Refrigerant release between detection and closing the safety shut-off valves

The refrigerant amount released between the **leak detection system** giving an output signal and closing the **safety shut-off valves**, m_{r2} , shall be determined as:

$$m_{r2} = 0,0028 \times t_{cl} \quad (\text{QQ.4})$$

where

t_{cl} is the time from the **leak detection system** giving an output signal to the **safety shut-off valves** being fully closed in s;

0,0028 is the assumed leak rate in kg/s.

Compliance is checked by inspection and test to determine the value of t_{cl} .

QQ.4.3 Determination of m_{r3}

QQ.4.3.1 General

To determine the **releasable charge** after closing the shut-off valves, m_{r3} , which can leak into the occupied space, determine the **releasable charge** for each part (unit or piping), $m_{r3,i}$, that can leak into the occupied space after closing the shut-off valves by one of the following methods:

- determine apparent density, $\rho_{part,i}$, by measuring the pressure according to QQ.4.3.2;
- determine apparent density, $\rho_{part,i}$, by applying default values according to QQ.4.3.3;
- determine apparent density, $\rho_{part,i}$, according to QQ.4.3.4.

NOTE 1 The apparent density is the total mass of refrigerant in the part being evaluated divided by the total free internal volume of that part.

NOTE 2 These methods can be combined for evaluating each part.

A part shall be the piping or the indoor unit between the field connection points.

NOTE 3 The apparent densities that are determined in a part can be used to calculate the **releasable charge** after closing the shut-off valves for different configurations. For instance, the apparent density determined in the piping can be used for the calculation with different piping lengths that operate under the same condition.

The **releasable charge** after closing the shut-off valves, m_{r3} , shall be the sum of the charge of each part that can leak into the occupied space after closing the shut-off valves:

$$m_{r3} = \sum V_{part,i} \times \rho_{part,i} \quad (\text{QQ.5})$$

where

$V_{part,i}$ is the free internal volume in the evaluated part i in m³;

$\rho_{part,i}$ is the apparent density of refrigerant in the evaluated part i in kg/m³.

QQ.4.3.2 Determine apparent density, $\rho_{part,i}$, by measuring the pressure

To determine the apparent density, $\rho_{part,i}$, of the **releasable charge** after closing the shut-off valves for the evaluated part of the system by measuring the pressure, the following procedure shall be applied.

The appliance shall be installed according to the manufacturer's instructions. The most unfavourable combination of test samples shall be chosen.

NOTE The most unfavourable combination is the set-up that will create the highest apparent density.

*For the test in cooling or heating mode, the system is operated according to the condition specified in Clause QQ.6. The **refrigerating system** shall operate according to the **operating state** until steady state is reached for at least 30 min.*

For the test in standby mode, the system shall be stopped for 8 h after the cooling operation according to the condition specified in Clause QQ.6 for 30 min.

The refrigerant state (liquid, gas or mixture) for the evaluated part of the system shall be determined.

The pressure shall be measured at the refrigerant entering side for units and piping.

The apparent density for the evaluated part of the system, $\rho_{\text{part},i}$, shall be determined as:

- *for liquid piping: the density of saturated liquid at the pressure that is measured;*
- *for gas piping: the density of saturated gas at the pressure that is measured;*
- *for piping containing mixture of gas and liquid: the density of saturated liquid at the pressure that is measured;*
- *for indoor units: the density of saturated liquid at the pressure that is measured.*

QQ.4.3.3 Determine apparent density, $\rho_{\text{part},i}$, by default values

When no test is executed, the following method shall be applied.

The refrigerant state (liquid, gas or mixture) for the evaluated part of the system shall be determined.

The apparent density for the evaluated part of the system, $\rho_{\text{part},i}$, shall be determined as:

- for liquid piping: the density of saturated liquid at 10 °C;
- for gas piping: the density of saturated gas at 42 °C;
- for piping containing mixture of gas and liquid: the density of saturated liquid at 10 °C;
- for indoor units: the density of saturated liquid at 10 °C.

QQ.4.3.4 Determine apparent density, $\rho_{\text{part},i}$, by measuring the recovered refrigerant amount from the unit or piping

To determine the apparent density, $\rho_{\text{part},i}$, of the releasable refrigerant after closing the shut-off valves for the evaluated indoor unit or piping by measuring the recovered refrigerant amount, the following procedure shall be applied.

*The appliance including **safety shut-off valves** shall be installed according to the manufacturer's instructions. The most unfavourable combination of test samples shall be chosen.*

NOTE 1 If in doubt, multiple samples can be measured.

Shut-off valves for testing shall be installed upstream and downstream of the part where the apparent density is measured. Shut-off valves for testing shall be of the same type as the **safety shut-off valves** used for the appliances. The action to shut-off shall be made in accordance with the **normal operation** of the **safety shut-off valves**.

For the test in cooling or heating mode, the system is operated according to the condition specified in Clause QQ.6. The **refrigerating system** shall operate according to the **operating state** until steady state is reached for at least 30 min prior to closing the shut-off valves for testing.

For the test in standby mode, the system shall be operated in cooling mode according to the condition specified in Clause QQ.6 for 30 min, and then stopped for 8 h.

The refrigerant containing part of the unit which is to be evaluated is shut off completely from upstream and downstream by shut-off valves. The shut-off valves used for testing shall close simultaneously when the last **safety shut-off valve** closes during the safety shut-off sequence.

The part being evaluated shall then be evacuated and the recovered refrigerant amount, m_{rm} , shall be measured.

The test shall be repeated at least three times and the measured refrigerant amount, m_{rm} , shall be two standard deviations above the mean result.

NOTE 2 The calculation of the mean value and the standard deviations apply to each **operating state** separately.

The apparent density, $\rho_{part,i}$, of the evaluated part i is:

$$\rho_{part,i} = m_{rm} / V_{part,i} \quad (QQ.6)$$

where

m_{rm} is the measured refrigerant amount in the evaluated part i in kg;

$V_{part,i}$ is the internal free volume in the evaluated part i in m³.

QQ.5 Time before the leak is detected, t_{r1}

QQ.5.1 General

The time before a leak is detected, t_{r1} , in seconds (s) is determined by one of the following:

- where the **refrigerant sensor** location is in compliance with Annex MM when tested at the maximum airflow for the **operating state**, QQ.5.2 applies;
- where the **leak detection system** is in compliance with Annex PP, QQ.5.2 applies;
- for all other cases, QQ.5.3 applies.

QQ.5.2 Determination of t_{r1} by default time

The time for the **leak detection system** to give an output signal, t_{r1} , shall be 120 s.

NOTE 120 s = 90 s + 30 s. 90 is the time delay in seconds specified in Annex MM, 30 is the maximum response time of the **refrigerant sensor** in seconds specified in IEC TS 63542:2024. The time delay in seconds specified in Annex PP is 90 s, which is less than the 120 s.

QQ.5.3 Determination of t_{r1} based on effective room concentration

The time for the **refrigerant detection system** to give an output signal, t_{r1} , in seconds shall be determined as:

$$t_{r1} = (H_r \times A_{\min} \times \text{LFL} \times C_{\text{set}} / 0,002\ 8) + 30 \quad (\text{QQ.7})$$

where

H_r is the effective height of the indoor unit as determined in GG.10.3 in m;

$A_{\min}$ is the required minimum room area in m²;

LFL is the **lower flammability limit** in kg/m³;

C_{set} is the alarm set point of the sensor in % of **LFL**, including the sensor tolerances, that results in the highest C_{set} ;

0,002 8 is the assumed leak rate in kg/s;

30 is a constant.

NOTE 1 0,002 8 is the release rate in g/s for the **enhanced tightness refrigerating systems** under Clause GG.10, and 30 is the maximum response time of the **refrigerant sensor** in seconds specified in IEC TS 63542:2024.

NOTE 2 Detection is assumed when the room concentration reaches the alarm set point of the **refrigerant detection system**. Installing the appliance in a room larger than $A_{\min}$ will result in an overall safer situation, even though t_{r1} will be underestimated.

NOTE 3 This calculation method is typically used for remote **refrigerant sensors** and for appliances where there is too much airflow to detect a leak during the tests of Annex MM or Annex PP.

NOTE 4 It is assumed that the **refrigerant sensor** is able to detect the refrigerant concentration in the room where it is installed, for instance by being installed in the airstream of the unit or close to the floor.

QQ.6 Test conditions for releasable charge limited systems

For a **releasable charge limited system**, the following **operating states** and conditions specified in the instructions shall be applied as applicable:

- a) Compressor off with indoor temperature 27 °C and outdoor temperature 35 °C, with indoor fan ON;
- b) Compressor off with indoor temperature 27 °C and outdoor temperature 35 °C, with indoor fan OFF;
- c) Cooling mode with
 - the compressor running at maximum speed at the specified temperature, and
 - highest outdoor air temperature and highest airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate, and
 - highest indoor air temperature and highest indoor fan airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate;
- d) Heating mode with
 - the compressor running at maximum speed at the specified temperature, and
 - highest outdoor air temperature and highest airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate, and
 - highest indoor air temperature and highest indoor fan airflow allowed by the controls, or highest entering fluid temperature and highest fluid flow rate.

NOTE The fan can have a different maximum speed depending on the operating state and working temperature; the highest speed in that condition is relevant.

Bibliography

The Bibliography of Part 1 is applicable except as follows.

Addition:

IEC 60050-845, *International Electrotechnical Vocabulary (IEV) – Lighting*

IEC 60079-1:2014, *Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d"*

IEC 60079-11:2011, *Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"*

IEC 60079-15:2017, *Explosive atmospheres – Part 15: Equipment protection by type of protection "n"*

IEC 60079-29-1:2016, *Explosive atmospheres – Part 29-1: Gas detectors – Performance requirements of detectors for flammable gases*
IEC 60079-29-1:2016/AMD1:2020

IEC 60335-2-21, *Household and similar electrical appliances – Safety – Part 2-21: Particular requirements for storage water heaters*

IEC 60335-2-88, *Household and similar electrical appliances – Safety – Part 2-88: Particular requirements for humidifiers intended for use with heating, ventilation, or air-conditioning systems*

ISO 527-3, *Plastics – Determination of tensile properties – Part 3: Test conditions for films and sheets*

ISO 845, *Cellular plastics and rubbers – Determination of apparent density*

ISO 1043-1, *Plastics – Symbols and abbreviated terms – Part 1: Basic polymers and their special characteristics*

ISO 17584, *Refrigerant properties*

ISO 22712, *Refrigerating systems and heat pumps – Competence of personnel*

API recommended practice 2216 Third Edition, December 2003, *"Ignition risk of Hydrocarbon liquids and vapors by hot surface in the open air" API recommended practice 2216 Third Edition, December 2003*

ASTM E659, *Standard Test Method for Autoignition Temperature of Chemicals*

ASTM D4728-17, *Standard Test Method for Random Vibration Testing of Shipping Containers*

ASTM D6668, *Standard Test Method for Discrimination Between Flammability Ratings of F = 0 and F = 1*

LEMMON, E.W., BELL, I.H., HUBER, M.L., McLINDEN, M.O. *NIST Standard Reference Database 23: Reference Fluid Thermodynamic and Transport Properties-REFPROP*, Version 10.0, National Institute of Standards and Technology, Standard Reference Data Program, Gaithersburg, 2018

NFPA 921, *Guide for fire and explosion investigations* (2004) Section 25.4.3.2 "Hot surface ignition of flammable and combustible liquids" Scott Davis, Dylan Chavez and Harri Kytomaa, Exponent, SAE technical paper series 2006-01-1014

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

SOMMAIRE

AVANT-PROPOS	155
INTRODUCTION.....	158
1 Domaine d'application	159
2 Références normatives	160
3 Termes et définitions	162
4 Exigences générales	170
5 Conditions générales d'essais	170
6 Classification	171
7 Marquage et instructions	171
8 Protection contre l'accès aux parties actives.....	177
9 Démarrage des appareils à moteur	177
10 Puissance et courant	177
11 Échauffements.....	177
12 Charge des batteries à ions métalliques	181
13 Courant de fuite et rigidité diélectrique à la température de régime	181
14 Surtensions transitoires	181
15 Résistance à l'humidité.....	181
16 Courant de fuite et rigidité diélectrique	182
17 Protection contre la surcharge des transformateurs et des circuits associés	183
18 Endurance	183
19 Fonctionnement anormal	183
20 Stabilité et dangers mécaniques	191
21 Résistance mécanique.....	191
22 Construction	193
23 Conducteurs internes.....	207
24 Composants	207
25 Raccordement au réseau et câbles souples extérieurs	208
26 Bornes pour conducteurs externes	209
27 Dispositions en vue de la mise à la terre	209
28 Vis et connexions	209
29 Distances dans l'air, lignes de fuite et isolation solide.....	209
30 Résistance à la chaleur et au feu.....	209
31 Protection contre la rouille	210
32 Rayonnement, toxicité et dangers analogues	211
Annexes	217
Annexe D (normative) Protecteurs thermiques des moteurs	217
Annexe I (normative) Moteurs ayant une isolation principale inappropriée pour la tension assignée de l'appareil	217
Annexe AA (informative) Exemples de températures de régime de l'appareil	218
Annexe BB (normative) Informations concernant les fluides frigorigènes.....	219
Annexe CC (informative) Transport, marquage et entreposage des unités qui utilisent des fluides frigorigènes inflammables	223

Annexe DD (normative) Exigences applicables aux manuels d'installation, d'entretien de maintenance et de réparation, et de mise hors service d'appareils utilisant des fluides frigorigènes inflammables	224
Annexe EE (normative) Essais de pression	235
Annexe FF (normative) Essais de simulation de fuite	237
Annexe GG (normative) Limites de charge, exigences de ventilation et exigences pour les circuits secondaires	239
Annexe HH (informative) Compétences du personnel de service	275
Annexe II (Vacant)	278
Annexe JJ (normative) Ouverture admissible des relais et composants analogues pour empêcher l'inflammation des fluides frigorigènes A2L	279
Annexe KK (normative) Méthode d'essai pour la température d'inflammation des surfaces brûlantes des fluides frigorigènes A2L	281
Annexe LL (Vacant)	285
Annexe MM (normative) Essai de confirmation de l'emplacement du capteur de fluides frigorigènes	286
Annexe NN (normative) Essai de vérification de l'enveloppe arrête-flammes pour les fluides frigorigènes A2L	289
Annexe OO (Vacant)	291
Annexe PP (normative) Essai de confirmation du système de détection des fuites pour les fluides frigorigènes inflammables	292
Annexe QQ (normative) Méthodes d'essai pour la détermination de la charge libérable	298
Bibliographie	307
Figure 101 – Exemple d'étiquette pour les unités chargées sur place	212
Figure 102 – Dispositif d'essai d'échauffement pour les appareils comportant un chauffe-air supplémentaire	214
Figure 103 – Circuit d'alimentation pour l'essai à rotor bloqué d'un moteur monophasé	215
Figure 104 – Profil de densité spectrale de puissance pour l'essai de vibration du 21.101	215
Figure 105 – Détails dimensionnels du poids dans la zone de la bille de pression	215
Figure 106 – Mesurage avant et après l'essai	216
Figure GG.1 – Zones non ventilées	271
Figure GG.2 – Ventilation mécanique	272
Figure GG.3 – Hauteurs appropriées h_{inst} , h_0 et h_{rel} pour le calcul de A_{min} et de m_{max}	273
Figure GG.4 – Direction du débit d'air	274
Figure KK.1 – Vue de face des étiquettes de l'appareillage d'essai	281
Figure KK.2 – Appareillage d'essai avec dimensions	282
Figure KK.3 – Vue du dessus de l'appareillage d'essai	283
Tableau 101 – Profil de densité spectrale de puissance pour l'essai de vibration	191
Tableau 102 – Emplacement de mesure de l'éclairement spectral UV-C	212
Tableau AA.1 – Exemples de températures de régime de l'appareil	218
Tableau BB.1 – Informations concernant les fluides frigorigènes	219
Tableau DD.1 – Articles obligatoires dans chacune des instructions	224

Tableau GG.1 – Aperçu de l'Annex G	240
Tableau GG.2 – Débit d'air de circulation	245
Tableau GG.3 – Appareil avec emballage	253
Tableau GG.4 – Appareil sans emballage	253
Tableau GG.5 – Vitesse minimale de l'air	266
Tableau GG.6 – Débit de fuite du fluide frigorigène ($\dot{m}_{\text{leak}}$)	270

IECNORM.COM : Click to view the full PDF of IEC 60335-2-40:2024 EXV

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

**APPAREILS ÉLECTRODOMESTIQUES ET ANALOGUES –
SÉCURITÉ –****Partie 2-40: Exigences particulières pour les pompes
à chaleur électriques, les climatiseurs et les déshumidificateurs****AVANT-PROPOS**

- 1) La Commission Électrotechnique Internationale (IEC) est une organisation mondiale de normalisation composée de l'ensemble des comités électrotechniques nationaux (Comités nationaux de l'IEC). L'IEC a pour objet de favoriser la coopération internationale pour toutes les questions de normalisation dans les domaines de l'électricité et de l'électronique. À cet effet, l'IEC – entre autres activités – publie des Normes internationales, des Spécifications techniques, des Rapports techniques, des Spécifications accessibles au public (PAS) et des Guides (ci-après dénommés "Publication(s) de l'IEC"). Leur élaboration est confiée à des comités d'études, aux travaux desquels tout Comité national intéressé par le sujet traité peut participer. Les organisations internationales, gouvernementales et non gouvernementales, en liaison avec l'IEC, participent également aux travaux. L'IEC collabore étroitement avec l'Organisation Internationale de Normalisation (ISO), selon des conditions fixées par accord entre les deux organisations.
- 2) Les décisions ou accords officiels de l'IEC concernant les questions techniques représentent, dans la mesure du possible, un accord international sur les sujets étudiés, étant donné que les Comités nationaux de l'IEC intéressés sont représentés dans chaque comité d'études.
- 3) Les Publications de l'IEC se présentent sous la forme de recommandations internationales et sont agréées comme telles par les Comités nationaux de l'IEC. Tous les efforts raisonnables sont entrepris afin que l'IEC s'assure de l'exactitude du contenu technique de ses publications; l'IEC ne peut pas être tenue responsable de l'éventuelle mauvaise utilisation ou interprétation qui en est faite par un quelconque utilisateur final.
- 4) Dans le but d'encourager l'uniformité internationale, les Comités nationaux de l'IEC s'engagent, dans toute la mesure possible, à appliquer de façon transparente les Publications de l'IEC dans leurs publications nationales et régionales. Toutes divergences entre toutes Publications de l'IEC et toutes publications nationales ou régionales correspondantes doivent être indiquées en termes clairs dans ces dernières.
- 5) L'IEC elle-même ne fournit aucune attestation de conformité. Des organismes de certification indépendants fournissent des services d'évaluation de conformité et, dans certains secteurs, accèdent aux marques de conformité de l'IEC. L'IEC n'est responsable d'aucun des services effectués par les organismes de certification indépendants.
- 6) Tous les utilisateurs doivent s'assurer qu'ils sont en possession de la dernière édition de cette publication.
- 7) Aucune responsabilité ne doit être imputée à l'IEC, à ses administrateurs, employés, auxiliaires ou mandataires, y compris ses experts particuliers et les membres de ses comités d'études et des Comités nationaux de l'IEC, pour tout préjudice causé en cas de dommages corporels et matériels, ou de tout autre dommage de quelque nature que ce soit, directe ou indirecte, ou pour supporter les coûts (y compris les frais de justice) et les dépenses découlant de la publication ou de l'utilisation de cette Publication de l'IEC ou de toute autre Publication de l'IEC, ou au crédit qui lui est accordé.
- 8) L'attention est attirée sur les références normatives citées dans cette publication. L'utilisation de publications référencées est obligatoire pour une application correcte de la présente publication.
- 9) L'IEC attire l'attention sur le fait que la mise en application du présent document peut entraîner l'utilisation d'un ou de plusieurs brevets. L'IEC ne prend pas position quant à la preuve, à la validité et à l'applicabilité de tout droit de brevet revendiqué à cet égard. À la date de publication du présent document, l'IEC n'avait pas reçu notification qu'un ou plusieurs brevets pouvaient être nécessaires à sa mise en application. Toutefois, il y a lieu d'avertir les responsables de la mise en application du présent document que des informations plus récentes sont susceptibles de figurer dans la base de données de brevets, disponible à l'adresse <https://patents.iec.ch>. L'IEC ne saurait être tenue pour responsable de ne pas avoir identifié de tels droits de brevets.

L'IEC 60335-2-40 a été établie par le sous-comité 61D: Appareils de conditionnement d'air pour usage domestique et commercial, du comité d'études 61 de l'IEC: Sécurité des appareils électrodomestiques et analogues. Il s'agit d'une Norme internationale.

Cette huitième édition annule et remplace la septième édition parue en 2022. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- a) Article 0: l'Article 0 de la Partie 1 s'applique désormais;
- b) Article 19: ajout d'une exigence pour la résistance au gel des **échangeurs de chaleur à double paroi**;
- c) Article 20: modification de l'exigence relative à l'application du calibre d'essai 18;
- d) Article 21: ajout d'une exigence pour la résistance des **échangeurs de chaleur à double paroi** à la pression du fluide frigorigène en cas de défaillance de l'une des parois;
- e) Article 22: modification de l'exigence pour tenir compte du fait que les appareils peuvent fonctionner en continu et à distance sans présenter de danger, et ajout d'une exigence précisant que les **échangeurs de chaleur à double paroi** doivent être construits de manière à éviter les fuites de fluide frigorigène dans le circuit secondaire;
- f) l'Annexe LL a été supprimée et remplacée par une référence à l'IEC TS 63542:2024.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
61D/538/FDIS	61D/542/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/publications.

Une liste de toutes les parties de la série IEC 60335, publiées sous le titre général *Appareils électrodomestiques et analogues – Sécurité*, se trouve sur le site web de l'IEC.

La présente partie 2 doit être utilisée conjointement avec la dernière édition de l'IEC 60335-1 et ses amendements sauf si cette édition l'exclut. Dans ce cas, la dernière édition qui n'exclut pas la présente partie 2 est utilisée. Elle a été établie sur la base de la sixième édition (2020) de cette norme.

NOTE 1 L'expression "la Partie 1" utilisée dans la présente norme fait référence à l'IEC 60335-1.

La présente partie 2-40 complète ou modifie les articles correspondants de l'IEC 60335-1, de façon à transformer cette publication en norme IEC: Exigences particulières pour les pompes à chaleur électriques, les climatiseurs et les déshumidificateurs.

Lorsqu'un paragraphe particulier de la Partie 1 n'est pas mentionné dans cette partie 2, ce paragraphe s'applique pour autant que cela soit raisonnable. Lorsque la présente norme mentionne "addition", "modification" ou "remplacement", le texte correspondant de la Partie 1 doit être adapté en conséquence.

NOTE 2 Le système de numérotation suivant est utilisé:

- les paragraphes, tableaux et figures qui s'ajoutent à ceux de la Partie 1 sont numérotés à partir de 101;
- à l'exception de celles qui sont dans un nouveau paragraphe ou de celles qui concernent des notes de la Partie 1, les notes sont numérotées à partir de 101, y compris celles des articles ou paragraphes qui sont remplacés;
- les annexes qui sont ajoutées sont désignées AA, BB, etc.

NOTE 3 Les caractères d'imprimerie suivants sont utilisés:

- exigences: caractères romains;

- *modalités d'essais: caractères italiques;*
- notes: petits caractères romains.

Les termes en **gras** dans le texte sont définis à l'Article 3. Lorsqu'une définition concerne un adjectif, l'adjectif et nom associé figurent également en gras.

Les différences suivantes, à caractère moins permanent, existent dans les pays indiqués ci-après:

- 6.1: Les appareils de la classe 0I sont autorisés (Japon).
- 11.8: La température des parois en bois du caisson d'essai est limitée à 85 °C (Suède).

Le comité a décidé que le contenu de ce document ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives au document recherché. À cette date, le document sera

- reconduit,
- supprimé, ou
- révisé.

IMPORTANT – Le logo "colour inside" qui se trouve sur la page de couverture de ce document indique qu'il contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer ce document en utilisant une imprimante couleur.

INTRODUCTION

Il a été admis par hypothèse, en établissant la présente Norme internationale, que l'exécution de ses dispositions était confiée à des personnes expérimentées et ayant une qualification appropriée.

Les documents de recommandations concernant l'application des exigences de sécurité pour les appareils peuvent être consultés dans les documents de support du CE 61, accessibles sur le site web de l'IEC à l'adresse:

<https://www.iec.ch/tc61/supportingdocuments>

Cette information est donnée à l'intention des utilisateurs de la présente Norme internationale et ne constitue nullement un remplacement du texte normatif de la présente norme.

La présente norme reconnaît le niveau de protection internationalement accepté contre les risques électriques, mécaniques, thermiques, liés au feu et au rayonnement des appareils, lorsqu'ils fonctionnent comme en usage normal en tenant compte des instructions. Elle couvre également les situations anormales qui peuvent être attendues dans la pratique.

Cette norme tient compte autant que possible des exigences de l'IEC 60364, de façon à rester compatible avec les règles d'installation quand l'appareil est raccordé au réseau d'alimentation. Cependant, des règles d'installation nationales peuvent être différentes.

Si un appareil relevant du domaine d'application de la présente norme comporte également des fonctions couvertes par une autre partie 2 de l'IEC 60335, la partie 2 correspondante est appliquée à chaque fonction séparément, dans la limite du raisonnable. Si cela s'applique, l'influence d'une fonction sur les autres fonctions est prise en compte.

Lorsqu'une partie 2 ne comporte pas d'exigences complémentaires pour couvrir les dangers traités dans la Partie 1, la Partie 1 s'applique.

NOTE 1 Cela signifie que les comités d'études responsables pour les parties 2 ont déterminé qu'il n'était pas nécessaire de spécifier des exigences particulières pour l'appareil en question en plus des exigences générales.

Cette norme est une norme de famille de produits traitant de la sécurité d'appareils et a préséance sur les normes horizontales et génériques couvrant le même sujet.

NOTE 2 Les publications horizontales, les publications fondamentales de sécurité et les publications groupées de sécurité couvrant un danger ne s'appliquent pas, parce qu'elles ont été prises en considération lorsque les exigences générales et particulières ont été étudiées pour la série de normes IEC 60335.

Un appareil conforme au texte de la présente norme ne sera pas nécessairement jugé conforme aux principes de sécurité de la norme si, lorsqu'il est examiné et soumis aux essais, il apparaît qu'il présente d'autres caractéristiques qui compromettent le niveau de sécurité visé par ces exigences.

Un appareil utilisant des matériaux ou présentant des modes de construction différents de ceux décrits dans les exigences de la présente norme peut être examiné et soumis aux essais en fonction de l'objectif poursuivi par ces exigences et, s'il est jugé pratiquement équivalent, il peut être estimé conforme aux principes de sécurité de la présente norme.

NOTE 3 Les normes traitant des aspects non relatifs à la sécurité des appareils électrodomestiques sont:

- les normes IEC publiées par le comité d'études 59 concernant les méthodes de mesure de l'aptitude à la fonction;
- les normes CISPR 11 et CISPR 14-1, ainsi que les normes applicables de la série IEC 61000-3 concernant les émissions électromagnétiques;
- la norme CISPR 14-2 concernant l'immunité électromagnétique;
- les normes IEC publiées par le comité d'études 111 concernant l'environnement.

APPAREILS ÉLECTRODOMESTIQUES ET ANALOGUES – SÉCURITÉ –

Partie 2-40: Exigences particulières pour les pompes à chaleur électriques, les climatiseurs et les déshumidificateurs

1 Domaine d'application

L'article de la Partie 1 est remplacé par le texte suivant.

La présente partie de l'IEC 60335 traite de la sécurité des **pompes à chaleur** électriques, des **pompes à chaleur pour production d'eau chaude sanitaire** et des **climatiseurs**, qui comportent des motocompresseurs ainsi que des **ventiloconvecteurs hydroniques**, des **déshumidificateurs** (avec ou sans motocompresseur), des **pompes à chaleur thermoélectriques** et des **unités partielles**. Leur **tension assignée** maximale n'est pas supérieure à 300 V pour les appareils monophasés et à 600 V pour les autres appareils, y compris les appareils alimentés en courant continu et les **appareils alimentés par batteries**.

Les appareils non destinés à un usage domestique normal, mais qui peuvent néanmoins constituer une source de danger pour le public, tels que les appareils destinés à être utilisés par des usagers non avertis dans des magasins, chez des artisans et dans des fermes, sont compris dans le domaine d'application de la présente norme.

Les appareils indiqués ci-dessus peuvent consister en un ou plusieurs ensembles fabriqués en usine. Lorsque les appareils sont fournis en plusieurs ensembles, les ensembles sont utilisés conjointement et les exigences correspondantes dépendent de l'utilisation des ensembles assortis.

NOTE 101 Une définition du terme "motocompresseur" est donnée dans l'IEC 60335-2-34 qui indique que le terme "motocompresseur" est utilisé pour désigner un motocompresseur hermétique ou semi-hermétique.

NOTE 102 En outre, l'IEC 60335-2-21 spécifie les exigences relatives aux cuves destinées au stockage de l'eau chauffée dans les **pompes à chaleur pour production d'eau chaude sanitaire**.

La présente norme ne couvre pas les fluides frigorigènes qui n'appartiennent pas aux groupes A1, A2L, A2 et A3 qui sont définis dans l'ISO 817. Les **fluides frigorigènes inflammables** se limitent à ceux dont la masse molaire est supérieure ou égale à 42 kg/kmol d'après la formule "la plus défavorable" (WCF, *Worst Case Formulation*) spécifiée dans l'ISO 817.

Dans la mesure du possible, la présente norme traite des dangers courants engendrés par les appareils qui sont rencontrés dans le cadre d'une utilisation normale et elle prend pour hypothèse que l'installation, l'entretien, la mise hors service et la mise au rebut sont effectués en toute sécurité par des personnes compétentes et que le dégagement accidentel de fluides frigorigènes est évité. Toutefois, elle ne spécifie pas les critères qui permettent d'assurer la compétence des personnes lors de l'installation, de l'entretien et de la mise au rebut. Les exigences de sécurité pendant la mise au rebut ne sont pas spécifiées dans la présente norme.

NOTE 103 L'Annexe HH fournit des exigences informatives relatives à la compétence du personnel. Les critères de compétence du personnel aux fins des systèmes de certification figurent dans l'ISO 22712.

Sauf spécification contraire dans la présente norme et ses annexes, les exigences relatives à la sécurité des systèmes frigorifiques sont spécifiées dans:

– l'ISO 5149-1:2014, l'ISO 5149-1:2014/AMD1:2015 et l'ISO 5149-1:2014/AMD2:2021;

- l'ISO 5149-2:2014 et l'ISO 5149-2:2014/AMD1:2020;
- l'ISO 5149-3:2014 et l'ISO 5149-3:2014/AMD1:2021.

Les **dispositifs de chauffage supplémentaires** (ou les dispositions concernant leur installation) sont couverts par le domaine d'application de la présente norme, mais uniquement les dispositifs de chauffage qui sont conçus en tant que partie de l'appareil, les commandes étant incorporées à l'appareil.

NOTE 104 L'attention est attirée sur le fait que

- pour les appareils destinés à être utilisés dans des véhicules ou à bord de navires ou d'avions, des exigences supplémentaires peuvent être nécessaires;
- dans de nombreux pays, des exigences supplémentaires sont spécifiées par exemple par les organismes nationaux de la santé publique responsables de la protection des travailleurs et par les organismes nationaux responsables du stockage, du transport, de la construction des bâtiments et des installations.

La présente norme ne s'applique pas

- aux humidificateurs destinés à être utilisés avec des appareils de chauffage et de refroidissement (IEC 60335-2-88);
- aux appareils prévus exclusivement pour des usages industriels;
- aux appareils destinés à être utilisés dans des locaux qui présentent des conditions particulières, telles que la présence d'une atmosphère corrosive ou explosive (poussière, vapeur ou gaz).

2 Références normatives

L'article de la Partie 1 s'applique, avec l'exception suivante.

Addition:

IEC 60068-2-52, *Essais d'environnement – Partie 2-52: Essais – Essai Kb: Brouillard salin, essai cyclique (solution de chlorure de sodium)*

IEC 60079-0, *Atmosphères explosives – Partie 0: Matériel – Exigences générales*

IEC 60079-7:2015, *Atmosphères explosives – Partie 7: Protection du matériel par sécurité augmentée "e"*

IEC 60079-7:2015/AMD1:2017

IEC 60079-14, *Atmosphères explosives – Partie 14: Conception, sélection et construction des installations électriques*

IEC 60079-15:2017, *Atmosphères explosives – Partie 15: Protection du matériel par mode de protection "n"*

IEC 60335-2-34:2021, *Appareils électrodomestiques et analogues – Sécurité – Partie 2-34: Exigences particulières pour les motocompresseurs*

IEC 60335-2-51, *Appareils électrodomestiques et analogues – Sécurité – Partie 2-51: Exigences particulières pour les pompes de circulation fixes pour installations de chauffage et de distribution d'eau*

IEC 60695-1-10, *Essais relatifs aux risques du feu – Partie 1-10: Lignes directrices pour l'évaluation des risques du feu des produits électrotechniques – Lignes directrices générales*

IEC 60695-10-2:2014, *Essais relatifs aux risques du feu – Partie 10-2: Chaleurs anormales – Essai à la bille*

IEC 60730-2-6, *Dispositifs de commande électrique automatiques – Partie 2-6: Exigences particulières pour les dispositifs de commande électrique automatiques sensibles à la pression y compris les exigences mécaniques*

IEC 62471:2006, *Sécurité photobiologique des lampes et des appareils utilisant des lampes*

IEC TS 63542:2024, *Refrigerant detection systems for flammable refrigerants* (disponible en anglais seulement)

ISO 527-3, *Plastiques – Détermination des propriétés en traction – Partie 3: Conditions d'essai pour films et feuilles*

ISO 817, *Refrigerants – Designation and safety classification* (disponible en anglais seulement)

ISO 1302¹, *Spécification géométrique des produits (GPS) – Indication des états de surface dans la documentation technique de produits*

ISO 2578, *Plastiques – Détermination des limites temps-températures après exposition à l'action prolongée de la chaleur*

ISO 5149-1:2014, *Systèmes frigorifiques et pompes à chaleur – Exigences de sécurité et d'environnement – Partie 1: Définitions, classification et critères de choix*
ISO 5149-1:2014/AMD1:2015
ISO 5149-1:2014/AMD2:2021

ISO 5149-2:2014, *Systèmes frigorifiques et pompes à chaleur – Exigences de sécurité et d'environnement – Partie 2: Conception, construction, essais, marquage et documentation*
ISO 5149-2:2014/AMD1:2020

ISO 5149-3:2014, *Systèmes frigorifiques et pompes à chaleur – Exigences de sécurité et d'environnement – Partie 3: Site d'installation*
ISO 5149-3:2014/AMD1:2021

ISO 5151, *Non-ducted air conditioners and heat pumps – Testing and rating for performance* (disponible en anglais seulement)

ISO 7010:2019, *Symboles graphiques – Couleurs de sécurité et signaux de sécurité – Signaux de sécurité enregistrés*

ISO 13253, *Ducted air-conditioners and air-to-air heat pumps – Testing and rating for performance* (disponible en anglais seulement)

ISO 13256 (toutes les parties), *Pompes à chaleur à eau – Essais et détermination des caractéristiques de performance*

ISO 13355, *Emballages – Emballages d'expédition complets et pleins et charges unitaires – Essais de vibration verticale aléatoire*

ISO 14903, *Systèmes de réfrigération et pompes à chaleur – Qualification de l'étanchéité des composants et des joints*

ISO 15042, *Climatiseurs et pompes à chaleur air/air multi-split – Essais et détermination des caractéristiques de performance*

¹ Supprimée.

3 Termes et définitions

L'article de la Partie 1 s'applique, avec les exceptions suivantes.

3.1.4 Addition:

Note 101 à l'article: Si l'appareil comprend des accessoires électriques, notamment des ventilateurs, la **puissance assignée** repose sur la **puissance électrique** maximale totale de l'ensemble des accessoires sous tension, lorsqu'ils fonctionnent en continu dans les conditions d'environnement appropriées. Si la **pompe à chaleur** peut être utilisée en mode chauffage ou refroidissement, la **puissance assignée** repose sur la puissance d'entrée en mode chauffage ou refroidissement, si cette valeur est plus élevée.

3.5.4 Addition:

Note 101 à l'article: Les appareils reliés à des tuyaux d'eau ou de fluide frigorigène qui sont fixés à des bâtiments sont également des **appareils installés à poste fixe**.

3.8.101

matériau en mousse de particules

matériau à alvéoles fermées moulé à partir de particules thermoplastiques (par exemple, des perles) avec un agent d'expansion

3.101

pompe à chaleur

appareil qui absorbe de la chaleur à une certaine température et la rejette à une température supérieure

Note 1 à l'article: Lorsqu'il est utilisé pour apporter de la chaleur (chauffage des locaux ou de l'eau, par exemple), l'appareil fonctionne en mode chauffage; lorsqu'il est utilisé pour éliminer la chaleur (refroidissement des locaux, par exemple), l'appareil fonctionne en mode refroidissement.

Note 2 à l'article: Une **pompe à chaleur** peut être une combinaison associant une **unité de condensation** ou une **unité de condenseur** avec une **unité d'évaporation** ou une **unité d'évaporateur**, et peut être équipée pour fonctionner en mode de cycle inverse.

3.102

pompe à chaleur pour production d'eau chaude sanitaire

pompe à chaleur destinée à chauffer l'eau destinée à la consommation humaine

3.103

climatiseur

un ou plusieurs ensembles enfermés dont la fonction est de fournir de l'air conditionné dans un espace clos, un local ou une zone

Note 1 à l'article: Il comprend un **système frigorigène** à moteur électrique pour refroidir, voire déshumidifier l'air.

Note 2 à l'article: Il peut comprendre des dispositifs pour le chauffage, la circulation, l'assainissement et l'humidification de l'air.

Note 3 à l'article: Un **climatiseur** peut être une combinaison associant une **unité de condensation** ou une **unité de condenseur** avec une **unité d'évaporation** ou une **unité d'évaporateur**.

3.104

déshumidificateur

ensemble enfermé dont la fonction est d'éliminer l'humidité présente dans l'atmosphère ambiante

Note 1 à l'article: Il comprend un **système frigorigène** à moteur électrique, ainsi que les dispositifs nécessaires à la circulation de l'air. Il est aussi équipé d'un dispositif de drainage qui permet de collecter et de stocker et/ou disperser les condensats.

3.108**température de bulbe humide****WB**

température indiquée lorsque l'élément thermosensible placé dans une mèche mouillée a atteint une température constante (équilibre d'évaporation)

Note 1 à l'article: L'abréviation "WB" est dérivée du terme anglais développé correspondant "wet-bulb temperature".

3.109**température de bulbe sec****DB**

température indiquée par un élément thermosensible à l'état sec et protégé contre les effets du rayonnement

Note 1 à l'article: L'abréviation "DB" est dérivée du terme anglais développé correspondant "dry-bulb temperature".

3.110**évaporateur**

échangeur de chaleur dans lequel le fluide frigorigène s'évapore en absorbant la chaleur

3.111**échangeur de chaleur**

appareil spécialement conçu pour transférer la chaleur entre deux fluides séparés physiquement (gaz ou liquides)

3.112**échangeur de chaleur intérieur**

échangeur de chaleur conçu pour transférer la chaleur à l'intérieur d'un local ou à l'alimentation en eau chaude intérieure (eau sanitaire, par exemple) ou pour éliminer la chaleur qui y est présente

3.113**échangeur de chaleur extérieur**

échangeur de chaleur conçu pour éliminer ou transférer la chaleur produite par la source de chaleur (eau de nappe, air extérieur, air extrait, eau ou saumure, par exemple)

3.114 Dispositifs de chauffage supplémentaires**3.114.1****dispositif de chauffage supplémentaire**

chauffage électrique qui complète ou remplace la sortie du circuit de fluide frigorigène dans le but de chauffer l'air ou l'eau

3.114.2**chauffe-eau supplémentaire**

dispositif de chauffage supplémentaire spécifique au chauffage de l'eau

3.114.3**chauffe-air supplémentaire**

dispositif de chauffage supplémentaire spécifique au chauffage de l'air conjoint au circuit frigorifique ou se substituant à celui-ci

Note 1 à l'article: Les **chauffe-air supplémentaires** comprennent les chauffages électriques qui font partie d'un appareil dont les circuits de fluide frigorigène sont uniquement à refroidissement.

3.115**dispositif limiteur de pression**

mécanisme qui réagit automatiquement à une pression prédéterminée en interrompant le fonctionnement de l'élément qui imprime une pression

3.116

limiteur de pression

soupape ou dispositif de rupture actionné par pression, qui élimine automatiquement les surpressions

3.117

appareils accessibles au public

appareils destinés à être placés dans des bâtiments d'habitation ou des bâtiments commerciaux dans un endroit sans accès restreint

3.118

appareils non accessibles au public

appareils situés dans un endroit sécurisé à accès restreint (salles de machines, toitures et similaires, par exemple, ou à une hauteur supérieure à 2,5 m)

3.119

ventiloconvecteur hydronique

ensemble fabriqué en usine qui assure la fonction de circulation d'air forcée pour le chauffage et/ou le refroidissement, qui peut également comprendre la fonction de **déshumidification** et/ou de filtrage de l'air, mais qui n'inclut pas la source de refroidissement ou de chauffage

Note 1 à l'article: Les **ventiloconvecteurs hydroniques** peuvent comporter un dispositif de chauffage par résistance électrique. Les bobines des **échangeurs de chaleur** sont uniquement destinées au chauffage et au refroidissement hydroniques.

3.120

fluide frigorigène inflammable

fluide frigorigène classé dans le groupe de sécurité A2L, A2 ou A3 selon l'ISO 817

3.121

système frigorifique

combinaison de parties interconnectées contenant des fluides frigorigènes qui constitue un circuit de fluide frigorigène fermé dans lequel circule le fluide frigorigène dans le but d'éliminer de la chaleur du côté basse température et de transférer de la chaleur du côté haute température en modifiant l'état du fluide frigorigène

3.122

pression maximale admissible

pression maximale pour laquelle est conçu l'équipement, spécifiée par le fabricant

Note 1 à l'article: La **pression maximale admissible** constitue une limite pour la pression de régime d'un **système frigorifique**, d'un circuit hydronique ou d'un réservoir d'eau chaude sanitaire lorsque l'équipement est en fonctionnement ou non (voir Article 21).

3.123

côté basse pression

une ou plusieurs parties d'un **système frigorifique** qui fonctionnent à la pression de l'évaporateur

3.124

côté haute pression

une ou plusieurs parties d'un **système frigorifique** qui fonctionnent à la pression du condenseur

3.125

accès de service

dispositif permettant d'accéder au fluide frigorigène à l'intérieur d'un **système frigorifique** à des fins de chargement ou d'entretien du système; il s'agit généralement d'une vanne, d'un tube prolongateur ou d'un point d'entrée

3.126**appareil monobloc scellé en usine**

assemblage en usine des composants d'un **système frigorifique** fixés sur un montage commun de manière à constituer une unité discrète dans laquelle tous les éléments du **système frigorifique** ont été scellés hermétiquement par soudage, par brasage ou par un raccordement à demeure analogue au cours du processus de fabrication

3.127**ensembles de tuyaux de précharge**

conduites de fluide frigorigène fournies avec l'unité et une **charge de fluide frigorigène** pour compléter le **système frigorifique** sur place dans le cas des appareils constitués de plusieurs sous-ensembles et assemblés sur place pour compléter le **système frigorifique**

3.128**condenseur**

échangeur de chaleur dans lequel un produit frigorigène à l'état gazeux se condense par élimination de la chaleur

3.129**unité de condensation**

ensemble fabriqué en usine qui comprend un ou plusieurs motocompresseurs, un **condenseur** en mode refroidissement ainsi qu'un ventilateur ou une pompe à moteur, dont la fonction est de faire circuler le fluide de transfert de chaleur dans le **condenseur** avec les commandes opérationnelles associées, en plus du câblage nécessaire

Note 1 à l'article: Ces unités sont destinées à être raccordées sur place à une **unité d'évaporateur**. Une **unité de condensation** peut également être équipée pour fonctionner en mode de cycle inverse. Une **unité de condensation** peut inclure un ou plusieurs dispositifs d'expansion.

3.130**unité de condenseur**

ensemble fabriqué en usine qui comprend un ou plusieurs **condenseurs** en mode refroidissement ainsi qu'un ventilateur ou une pompe à moteur, dont la fonction est de faire circuler le fluide de transfert de chaleur dans le **condenseur** avec les commandes opérationnelles associées, en plus du câblage nécessaire

Note 1 à l'article: Ces unités sont destinées à être raccordées sur place à une **unité d'évaporation**. Une **unité de condenseur** peut également être équipée pour fonctionner en mode de cycle inverse.

Note 2 à l'article: Une **unité de condenseur** n'inclut pas de motocompresseur ni de dispositif d'expansion.

3.131**unité d'évaporation**

ensemble fabriqué en usine qui comprend un ou plusieurs motocompresseurs, un **évaporateur** en mode refroidissement, un ou plusieurs dispositifs d'expansion, ainsi qu'un ventilateur ou une pompe à moteur, dont la fonction est de faire circuler le fluide dans l'**évaporateur** avec les commandes opérationnelles associées, en plus du câblage nécessaire

Note 1 à l'article: Ces unités sont destinées à être raccordées sur place à une **unité de condenseur**. Une **unité d'évaporation** peut également être équipée pour fonctionner en mode de cycle inverse et peut comporter un dispositif de chauffage par résistance électrique ou des sources de chaleur auxiliaire analogues.

3.132**unité d'évaporateur**

ensemble fabriqué en usine qui comprend un ou plusieurs **évaporateurs** en mode refroidissement et peut comprendre un ventilateur ou une pompe à moteur, dont la fonction est de faire circuler le fluide dans l'**évaporateur** avec les commandes opérationnelles associées, en plus du câblage nécessaire

Note 1 à l'article: Ces unités sont destinées au raccordement sur place à une **unité de condensation**. Une **unité d'évaporateur** peut également être équipée pour fonctionner en mode de cycle inverse et peut comporter un dispositif de chauffage par résistance électrique ou des sources de chaleur auxiliaire analogues. Une **unité d'évaporateur** peut inclure un ou plusieurs dispositifs d'expansion.

Note 2 à l'article: Une **unité d'évaporateur** n'inclut pas de motocompresseur.

3.133**unité partielle**

unité de condensation, unité d'évaporation, unité de condenseur ou unité d'évaporateur qui fait partie de l'ensemble final d'une **pompe à chaleur**, d'un **climatiseur** ou de **pompes à chaleur pour production d'eau chaude sanitaire**, lorsque tous les ensembles composant le **système frigorifique** complet ne sont pas spécifiés par le fabricant

Note 1 à l'article: Les **unités partielles** sont évaluées pour la sécurité en tant qu'unité autonome.

3.134**hauteur de montage** h_{inst}

hauteur entre le fond de l'appareil et le sol du local après installation

Note 1 à l'article: La **hauteur de montage** est exprimée en mètres.

3.135**évacuation déportée** h_{rel}

distance entre le fond de l'appareil et une ouverture où le fluide frigorigène peut quitter l'appareil en cas de fuite du fluide frigorigène

Note 1 à l'article: L'**évacuation déportée** est exprimée en mètres.

3.136**charge de fluide frigorigène** m_c

charge de fluide frigorigène réelle d'un **système frigorifique**

Note 1 à l'article: La **charge de fluide frigorigène** est exprimée en kg.

3.137**charge de fluide frigorigène maximale** m_{max}

charge de fluide frigorigène maximale pour un seul **système frigorifique** résultant d'un calcul de la surface du local ou d'un calcul analogue

Note 1 à l'article: La **charge de fluide frigorigène maximale** est exprimée en kg.

3.138**système de détection des fluides frigorigènes**

système de détection qui donne un signal de sortie en réponse à une concentration prédéfinie de fluide frigorigène dans l'environnement

Note 1 à l'article: Un **système de détection des fluides frigorigènes** peut comporter plusieurs **capteurs de fluide frigorigène**.

3.139**température d'autoinflammation****AIT**

température la plus basse à laquelle ou au-dessus de laquelle un produit chimique peut s'enflammer spontanément dans une atmosphère normale, sans source extérieure d'inflammation, telle qu'une flamme ou une étincelle

Note 1 à l'article: L'abréviation "AIT" est dérivée du terme anglais développé correspondant "autoignition temperature".

[SOURCE: ISO 5149-1:2014, 3.7.7, modifiée – L'abréviation "AIT" a été ajoutée, et "d'une matière" a été supprimé.]

3.140**température d'inflammation des surfaces brûlantes**

température la plus élevée à laquelle un fluide frigorigène ne s'enflamme pas au cours d'un essai conformément à l'Annexe KK

3.141**fluide frigorigène A2L**

fluide frigorigène classé dans le groupe de sécurité A2L selon l'ISO 817

3.142**limite inférieure d'inflammabilité****LFL**

concentration minimale de fluide frigorigène capable de propager une flamme à travers un mélange homogène de fluide frigorigène et d'air

Note 1 à l'article: Les données sont répertoriées à l'Annexe BB.

Note 2 à l'article: L'abréviation "LFL" est dérivée du terme anglais développé correspondant "lower flammability limit".

[SOURCE: ISO 817:2014, 3.1.24, modifiée – "dans les conditions d'essai spécifiées à 23,0 °C et 101,3 kPa" et les Notes à l'article ont été supprimés.]

3.143**système frigorifique à étanchéité renforcée**

système frigorifique dans lequel les unités intérieures sont conçues et fabriquées de façon à apporter un niveau élevé de confiance assurant l'absence de fuites importantes de fluide frigorigène en **fonctionnement normal** et anormal

3.144**ensemble de distribution de fluide frigorigène**

ensemble frigorifique séparé qui est installé dans les conduites de fluide frigorigène interconnectées dans le but de distribuer le débit de fluide frigorigène à une ou plusieurs unités intérieures

3.145**Vacant****3.146****débit d'air de circulation**

brassage mécanique de l'air à l'intérieur de l'espace ou des espaces reliés par des conduits

3.147

Vacant

3.148

Vacant

3.149

Vacant

3.150

lampe UV-C

source conçue pour produire un rayonnement ultraviolet dont la longueur d'onde est dans une plage comprise entre 100 nm et 280 nm

Note 1 à l'article: Il existe plusieurs types de lampes utilisées à des fins photobiologiques, photochimiques et biomédicales.

3.151

Vacant

3.152

système de lampes germicides UV-C

dispositif auxiliaire qui utilise des **lampes UV-C** générant directement un rayonnement germicide

Note 1 à l'article: Les **systèmes de lampes germicides UV-C** sont habituellement utilisés pour compléter les filtres à air d'une unité normale afin d'optimiser la purification de l'air et le nettoyage de surface de la bobine de l'évaporateur et de la zone environnante

3.153

éclairage spectral UV-C

densité de puissance de rayonnement électromagnétique mesurée à une longueur d'onde particulière de 254 nm à une distance spécifiée

Note 1 à l'article: L'éclairage spectral E_{254} est mesuré en $\mu\text{W}/\text{cm}^2$.

3.154

barrière UV-C

protecteur ou bouclier supplémentaire empêchant la lumière UV-C de sortir ou d'endommager des matériaux non métalliques internes

3.155

système frigorifique transcritique

système frigorifique dans lequel l'évaporation se produit au-dessous du point critique et le rejet de chaleur peut se produire au-dessus du point critique du fluide frigorigène (R744, par exemple)

3.156

charge libérable

m_{rl}

masse de fluide frigorigène qui peut être libérée dans l'espace intérieur par un **système frigorifique** en cas de fuite

Note 1 à l'article: Toute partie de la **charge de fluide frigorigène** qui fuit vers l'extérieur est exclue de la **charge libérable**.

3.157

état de fonctionnement

fonction dans laquelle se trouve l'appareil à un moment précis pendant le **fonctionnement normal**

Note 1 à l'article: Le mode veille, le mode refroidissement, le mode chauffage et le dégivrage en sont des exemples.

3.158**système à charge libérable limitée**

système frigorifique dans lequel la **charge libérable** est limitée par des mesures de conception

EXEMPLE 1 Les systèmes qui reposent sur la fermeture des **vannes d'arrêt de sécurité** lorsque le compresseur est à l'arrêt sont des exemples de **systèmes à charge libérable limitée** qui ne reposent pas sur des **systèmes de détection des fuites**.

EXEMPLE 2 Les systèmes qui reposent sur la mesure de la température, de la pression, sur la détection de fuites par ultrasons ou sur d'autres paramètres de fonctionnement pour détecter une fuite sont des exemples de **systèmes à charge libérable limitée** qui ne reposent pas sur des **systèmes de détection des fluides frigorigènes**.

3.159**vanne d'arrêt de sécurité**

vanne qui limite la quantité de la **charge libérable**

3.160**système de détection des fuites**

système de détection qui réagit aux fuites de fluide frigorigène d'un **système frigorifique**

EXEMPLE Un **système de détection des fluides frigorigènes** est un exemple de **système de détection des fuites**.

Note 1 à l'article: Un **système de détection des fuites** peut inclure la détection de gaz, les ultrasons ou d'autres méthodes de ce type dont l'efficacité a été démontrée.

3.161**point de fuite potentiel**

tout point du **système frigorifique** qui peut constituer un point faible en raison des procédés de fabrication, de l'exposition à des dommages, de la netteté d'un coude, ou de contraintes similaires

EXEMPLE Les **points de fuite potentiels** peuvent comprendre des parties soumises à des contraintes ou à des vibrations.

3.162**réceptacle sous pression**

toute partie d'un système frigorifique contenant du fluide frigorigène autre que:

- compresseurs;
- pompes;
- composants des systèmes scellés à absorption;
- évaporateurs, dont chaque section individuelle a un volume contenant le fluide frigorigène de 15 litres au maximum;
- serpentins;
- tuyauteries et leurs robinets, les joints et les raccords;
- dispositifs de commande; et
- composants sous pression (collecteurs compris) dont le diamètre intérieur ou la plus grande dimension transversale n'est pas supérieure à 152 mm

[SOURCE: ISO 5149-1:2014, 3.4.7]

3.163**capteur de fluide frigorigène**

ensemble dans lequel est logé l'élément sensible et qui peut également contenir des composants du circuit associés

[SOURCE: IEC 60079-29-1:2016, 3.3.2 modifié – "capteur" a été remplacé par "capteur de fluide frigorigène".]

3.164

capteur de fluide frigorigène à durée de vie limitée

capteur de fluide frigorigène réputé tomber en panne pendant la durée de vie de l'appareil

3.165

pompe à chaleur thermoélectrique

pompe à chaleur à semiconducteurs, activée par un courant électrique, qui absorbe la chaleur à une certaine température et la restitue à une température plus élevée

Note 1 à l'article: Un élément Peltier est un exemple de cette technologie.

3.166

échangeur de chaleur à double paroi

échangeur de chaleur avec deux parois entre le fluide frigorigène et un fluide secondaire

Note 1 à l'article: L'**échangeur de chaleur à double paroi** empêche la pénétration de fluide frigorigène dans le circuit secondaire ou celle du fluide secondaire dans le circuit frigorifique en cas de fuite dans une paroi de séparation.

4 Exigences générales

L'article de la Partie 1 s'applique.

5 Conditions générales d'essais

L'article de la Partie 1 s'applique, avec les exceptions suivantes.

5.2 Addition:

*Les essais de l'Article 21 peuvent être effectués sur des échantillons distincts. Les essais des Articles 11, 19 et 21 doivent exiger des mesurages de la pression en différents points du **système frigorifique**.*

NOTE 101 À titre de référence, les températures de la tuyauterie de fluide frigorigène peuvent être mesurées pendant l'essai de l'Article 11.

*Lorsque les essais de l'Annexe FF (essais de simulation de fuite) et de l'Annexe QQ (méthodes pour la détermination de la **charge libérable**) sont effectués, au moins un échantillon supplémentaire spécialement préparé est exigé.*

Si l'essai de l'Annexe NN doit être effectué, un appareil supplémentaire peut être utilisé.

Les essais de l'Article 15 peuvent être effectués sur un échantillon distinct. L'essai des 19.104.2 à 19.104.8 peut être effectué dans n'importe quel ordre à l'Article 19.

5.6 Addition:

Tous les dispositifs de réglage de température ou d'humidité de l'espace conditionné sont rendus inopérants pendant l'essai.

5.7 Addition:

Les essais et les conditions d'essai des Articles 10 et 11 sont appliqués dans les conditions de fonctionnement les plus défavorables à l'intérieur de la plage de températures de régime spécifiée par le fabricant. L'Annexe AA fournit des exemples de telles conditions de température.

5.10 Addition:

Pour les appareils split, les conduites de fluide frigorigène doivent être installées conformément aux instructions d'installation. La longueur des tuyaux doit être comprise entre 5 m et 7,5 m. Lorsque les instructions d'installation spécifient une longueur maximale des tuyaux inférieure à 5 m, la longueur des tuyaux doit être la longueur maximale spécifiée dans les instructions d'installation, et lorsque les instructions d'installation spécifient une longueur minimale des tuyaux supérieure à 7,5 m, la longueur des tuyaux doit être la longueur minimale spécifiée dans les instructions d'installation. L'isolation thermique des conduites de fluide frigorigène doit être appliquée conformément aux instructions d'installation.

6 Classification

L'article de la Partie 1 s'applique, avec les exceptions suivantes.

6.1 Modification:

Les appareils doivent être de la **classe I**, de la **classe II** ou de la **classe III**.

6.2 Addition:

Les appareils doivent être classés selon leur degré de protection contre les effets nuisibles dus à la pénétration de l'eau conformément à l'IEC 60529:

- les appareils ou les parties d'appareils utilisés à l'extérieur des bâtiments doivent être au moins de la classe IPX4;
- les appareils utilisés uniquement à l'intérieur des bâtiments (à l'exception des buanderies) peuvent être de la classe IPX0;
- les appareils utilisés dans les buanderies doivent être au moins de la classe IPX1.

6.101 Les appareils doivent être classés suivant leur accessibilité soit comme **appareil accessible au public** soit comme **appareil non accessible au public**.

La conformité est vérifiée par examen.

7 Marquage et instructions

L'article de la Partie 1 s'applique, avec les exceptions suivantes.

7.1 Modification:

Remplacer le deuxième tiret par:

- symbole pour la nature de l'alimentation comprenant le nombre de phases, à l'exception du fonctionnement monophasé;

Addition:

- **fréquence assignée;**
- **charge de fluide frigorigène** pour chaque **système frigorifique;**
- désignation des fluides frigorigènes conformément à l'ISO 817;
- **pression maximale admissible** pour le réservoir de stockage (pour les **pompes à chaleur pour production d'eau chaude sanitaire**);
- **pression maximale admissible** dans le circuit d'eau et/ou le circuit de saumure pour l'**échangeur de chaleur** pour les **ventiloconvecteurs hydroniques;**

- **pression maximale admissible** pour le circuit de fluide frigorigène; lorsque les **pressions maximales admissibles** diffèrent du côté aspiration et du côté refoulement, un marquage distinct est exigé;
- pour les **ensembles de tuyaux de précharge**:
 - désignation des fluides frigorigènes conformément à l'ISO 817;
 - **charge de fluide frigorigène** de l'ensemble de conduites;
 - **pression maximale admissible**;
 - lorsqu'ils sont chargés d'un fluide frigorigène inflammable, symbole de la flamme de l'ISO 7010-W021 (2011-05), y compris le groupe de sécurité selon l'ISO 817;
- courants assignés en watts et tension d'un **système de lampes germicides UV-C**, le cas échéant.

Les appareils doivent porter toutes les indications de la dénomination et des puissances assignées des **dispositifs de chauffage supplémentaires** pour lesquels ils sont conçus et un emplacement doit être prévu pour l'identification du chauffage supplémentaire effectivement installé sur place.

À moins que cela ne soit évident d'après la conception, l'enveloppe des appareils doit porter l'indication de la direction du fluide au moyen d'inscriptions ou de symboles.

Lorsqu'un **fluide frigorigène inflammable** est utilisé, un symbole d'avertissement (symbole de la flamme: ISO 7010-W021 (2011-05)), y compris le groupe de sécurité selon l'ISO 817 comme cela est décrit au 7.6, doit être placé à portée de vue du marquage de la désignation du fluide frigorigène sur l'appareil. La hauteur du symbole doit être d'au moins 10 mm et il n'est pas nécessaire que le symbole soit en couleur.

NOTE 101 La désignation du fluide frigorigène se trouve généralement sur la plaque signalétique de l'appareil.

Les appareils qui utilisent des **fluides frigorigènes inflammables** doivent porter le symbole de la flamme de l'ISO 7010-W021 (2011-05), y compris le groupe de sécurité selon l'ISO 817. La hauteur du triangle utilisé pour le symbole doit être d'au moins 30 mm. Les marquages exigés doivent être apposés sur l'ensemble des unités qui contiennent des compresseurs.

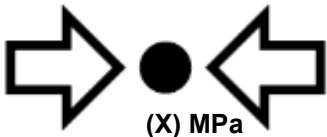
Si le type de fluide frigorigène n'est pas visible par l'**accès de service** (éventuellement fourni), l'**accès de service** doit porter un marquage d'identification du type de fluide frigorigène utilisé. Lorsque le fluide frigorigène est inflammable, le symbole de l'ISO 7010-W021 (2011-05) qui comprend le groupe de sécurité selon l'ISO 817 doit être inclus, sans spécifier la couleur.

Lorsqu'un **fluide frigorigène inflammable** est utilisé, les symboles "lire le manuel de l'opérateur" (symboles de l'ISO 7000-0790 (2004-01)) et "indicateur de service; lire le manuel d'entretien" (ISO 7000-1659 (2004-01)), doivent être apposés sur l'appareil à un emplacement visible pour les personnes qui doivent connaître cette information. La hauteur du symbole doit être d'au moins 10 mm.

Les appareils qui ne sont pas des **appareils installés à poste fixe**, utilisant un **fluide frigorigène inflammable** avec une **charge de fluide frigorigène** (m_c) de l'appareil supérieure à m_1 conformément au 0, doivent porter le symbole de l'ISO 7000-0434A (2004-01) immédiatement suivi du symbole de surface au sol minimale du local de l'IEC 60417-6412 (2019-03), où "A" est la surface minimale du local en m^2 déterminée conformément à l'Annexe GG. Les marquages doivent être apposés à l'extérieur de l'appareil de manière à être visibles en fonctionnement normal.

Les appareils qui utilisent des **systèmes frigorifiques** avec une **pression maximale admissible** supérieure à 7 MPa doivent porter le symbole de l'ISO 7000-1701 (2004-01) suivi du texte "(X) MPa" et du symbole "manuel de l'utilisateur" de l'ISO 7000-0790 (2004-01), où: "X" est la **pression maximale admissible**.

7.6 Addition:

	[symbole ISO 7000-1659 (2004-01)]	indicateur de service; lire le manuel d'entretien
 groupe de sécurité selon l'ISO 817	[symbole ISO 7010-W021 (2011-05) plus le groupe de sécurité selon l'ISO 817, au moins 1/3 de la hauteur du symbole au symbole]	avertissement; matériel inflammable
	[symbole ISO 7000-1701 (2004-01)]	pression
	[symbole IEC 60417-6040 (2010-08)]	rayonnement ultraviolet, instruction de protection
	[symbole IEC 60417-6412 (2019-03)]	surface au sol minimale du local

7.12.1 Addition:

En particulier, les informations suivantes doivent être fournies:

- les réglementations nationales en matière de câblage peuvent imposer des exigences supplémentaires;
- les dimensions de l'espace nécessaire pour assurer une installation correcte de l'appareil, notamment les distances minimales admissibles par rapport aux structures adjacentes;
- pour les appareils équipés de **chauffe-air supplémentaires**, les distances dans l'air minimales entre l'appareil et les surfaces combustibles;
- un schéma de câblage avec une indication claire des connexions, du raccordement des dispositifs de commande externes et du **câble d'alimentation**;
- la plage des pressions statiques extérieures auxquelles a été soumis à l'essai l'appareil (**pompes à chaleur** additionnelles et appareils raccordés équipés de **chauffe-air supplémentaires** uniquement);
- la méthode de raccordement de l'appareil au réseau électrique et les liaisons entre les différents composants;
- l'indication des parties de l'appareil qui conviennent à une utilisation en extérieur, si applicable;
- l'indication du type et du calibre des fusibles, ou le calibre des disjoncteurs;

- i) les détails sur les éléments chauffants supplémentaires qui peuvent être utilisés en conjonction avec l'appareil, notamment les instructions de montage soit avec l'appareil soit avec le **dispositif de chauffage supplémentaire**;
- j) les températures minimale et maximale de l'eau ou de la saumure en fonctionnement;
- k) les pressions minimale et maximale de l'eau ou de la saumure en fonctionnement;
- l) les températures minimale et maximale de fonctionnement de l'air intérieur et extérieur;
- m) les instructions sur le chargement des fluides frigorigènes lorsque le fabricant exige l'ajout de fluide frigorigène pour remplir le **système frigorigère**;
- n) lorsque le symbole de l'IEC 60417-6412 (2019-03) est utilisé, un avertissement qui indique que l'appareil doit être installé, utilisé et stocké dans un local dont la surface au sol n'est pas inférieure à la surface minimale du local.

Les réservoirs de stockage ouverts des **pompes à chaleur** destinées au chauffage de l'eau doivent être accompagnés d'une notice d'instructions précisant que l'orifice de ventilation ne doit pas être obstrué.

7.12.9 *Modification:*

Ajouter 7.12.101 et 7.12.102 après la référence à 7.12.1 au 7.12.8.

7.12.101 Pour les **appareils non accessibles au public**, la classification selon 6.101 doit être incluse.

La conformité est vérifiée par examen.

7.12.102 Pour les appareils qui utilisent des **fluides frigorigènes inflammables**, les instructions d'installation, les instructions d'entretien, de maintenance et de réparation, et les instructions de mise hors service (séparés ou combinés) doivent être mises à disposition et inclure les informations fournies à l'Annexe DD.

La conformité est vérifiée par examen.

L'Annexe CC fournit des recommandations supplémentaires pour le transport, le marquage et l'entreposage des unités qui utilisent des **fluides frigorigènes inflammables**.

7.15 *Addition:*

Un marquage peut être placé sur un panneau pouvant être retiré pour l'installation ou l'entretien, mais ce panneau doit être en place pour le fonctionnement prévu de l'appareil.

7.101 Les fusibles remplaçables ou les **dispositifs de protection** contre les surcharges remplaçables fournis comme une partie d'un produit ou d'un coffret de télécommande doivent être repérés par un marquage. Celui-ci doit être visible lorsque le couvercle ou la porte du compartiment est ouvert. Ce marquage doit spécifier:

- le calibre du fusible en ampères, le type et la tension assignée; ou
- le nom du fabricant et la désignation du modèle du **dispositif de protection** contre les surcharges remplaçable.

La conformité est vérifiée par examen.

7.102 Lorsque l'appareil est destiné à être raccordé à demeure à des canalisations fixes au moyen de conducteurs en aluminium, cela doit être indiqué sur le marquage.

La conformité est vérifiée par examen.

7.103 Pour les appareils constitués de plusieurs ensembles assemblés en usine qui doivent être utilisés ensemble d'après les spécifications du fabricant, des instructions doivent être fournies pour construire l'ensemble conformément aux exigences établies.

La conformité est vérifiée par examen.

7.104 Pour les **unités partielles**, les instructions ou les marquages doivent inclure les informations supplémentaires suivantes.

- Pour les **unités d'évaporation** et les **unités de condensation**, les instructions ou les marquages doivent comporter une mention qui assure que la pression de régime maximale est prise en compte lors de la connexion à une **unité de condenseur** ou à une **unité d'évaporateur**.
- Pour les **unités d'évaporation**, les **unités de condensation** et les **unités de condenseur**, les instructions ou les marquages doivent comprendre des instructions pour le chargement du fluide frigorigène.
- Un avertissement qui vise à assurer que les **unités partielles** ne doivent être raccordées qu'à un appareil adapté au même fluide frigorigène.
- L'unité <modèle xxx> est une **unité partielle** de **climatiseur** qui satisfait aux exigences de l'IEC 60335-2-40 en ce qui concerne les **unités partielles**. Cette unité doit uniquement être raccordée à d'autres unités dont la conformité aux exigences applicables aux **unités partielles** de l'IEC 60335-2-40 est avérée.
- Les interfaces électriques doivent être spécifiées en précisant l'objet, la tension, le courant et la classe de sûreté de la construction.
- Si des points de connexion **TBTS** sont fournis, ceux-ci doivent être clairement indiqués dans les instructions. Il convient de marquer le point de connexion à l'aide du symbole "lire les instructions" de l'ISO 7000-0790 (2004-01) et du symbole Classe III de l'IEC 60417-5180 (2003-02).

La conformité est vérifiée par examen.

7.105 Pour les appareils qui utilisent des **fluides frigorigènes inflammables** et qui comportent des dispositifs de sécurité reposant sur le bon fonctionnement d'un **système de détection des fuites**, les instructions ou les marquages des unités doivent comporter en substance les indications suivantes:

"Cette unité est équipée d'un **système de détection des fuites** à des fins de sécurité. Pour que la détection des fuites soit efficace, l'unité doit être continuellement alimentée en énergie électrique après l'installation, excepté durant les opérations d'entretien."

Lorsqu'un **capteur de fluide frigorigène** distant est utilisé pour détecter les fuites de fluide frigorigène, celui-ci doit également porter ce marquage ou être accompagné de telles instructions.

La conformité est vérifiée par examen.

7.106 Pour les appareils qui utilisent des **fluides frigorigènes inflammables** et qui comportent des dispositifs de sécurité reposant sur le bon fonctionnement des dispositifs de sécurité alimentés en énergie électrique, les instructions ou les marquages des unités doivent comporter en substance les indications suivantes:

"Cette unité est équipée de dispositifs de sécurité alimentés en énergie électrique. Pour que les mesures de sécurité soient efficaces, l'unité doit être continuellement alimentée en énergie électrique après l'installation, excepté durant les opérations d'entretien."

Lorsqu'une unité de ventilation mécanique est utilisée pour diluer les fuites de fluide frigorigène et qu'elle n'est pas intégrée à l'appareil, celle-ci doit également porter ce marquage ou être accompagnée de telles instructions.

La conformité est vérifiée par examen.

7.107 Pour les **fluides frigorigènes inflammables**, lorsque les instructions d'installation exigent l'ajout de charge pour remplir le **système frigorifique**, le fabricant doit fournir une étiquette qui permet à l'installateur de noter la **charge de fluide frigorigène** totale pour chaque **système frigorifique**. La Figure 101 représente un exemple d'étiquette pour les unités chargées sur place.

La conformité est vérifiée par examen.

7.108 Pour les appareils qui utilisent des **fluides frigorigènes inflammables**, à l'exclusion des appareils dont la **charge de fluide frigorigène A2L** ne dépasse pas m_1 , le symbole de la flamme de l'ISO 7010-W021 (2011-05), y compris le groupe de sécurité selon l'Annexe BB décrit au 7.6, doit être visible sur l'emballage de l'appareil lorsque celui-ci est chargé de fluide frigorigène.

La hauteur perpendiculaire du symbole doit être d'au moins 30 mm.

La conformité est vérifiée par examen.

7.109 Les appareils utilisant des **systèmes de lampes germicides UV-C** doivent être marqués du symbole de danger de rayonnement ultraviolet de l'IEC 60417-6040 (2010-08) et du symbole "lire le manuel de l'opérateur" de l'ISO 7000-0790 (2004-01) aux endroits suivants:

- sur les portes et les panneaux d'accès permettant un accès direct à une zone de l'appareil lorsque l'**éclairement spectral UV-C** est supérieur à $1,7 \mu\text{W}/\text{cm}^2$;
- sur les panneaux d'accès pour l'**entretien par l'utilisateur**;
- sur les **barrières UV-C**.

La conformité est vérifiée par examen.

7.110 Pour les appareils qui utilisent des **systèmes de lampes germicides UV-C**, les instructions doivent inclure en substance les informations suivantes:

- cet appareil contient une **lampe UV-C**;
- lire les instructions de maintenance avant d'ouvrir l'appareil;
- les procédures à suivre pour le nettoyage et l'**entretien par l'utilisateur** de l'appareil. Elles doivent indiquer que l'appareil doit être débranché du secteur avant de procéder à son nettoyage ou à toute autre opération d'entretien;
- la méthode, la fréquence de nettoyage, ainsi que les précautions nécessaires à prendre;
- les précautions à prendre en cas de remplacement des émetteurs et starters UV-C, le cas échéant;
- l'utilisation non intentionnelle de l'appareil ou les dommages causés au boîtier peuvent entraîner la fuite de rayonnements UV-C dangereux. Même à faibles doses, les rayonnements UV-C peuvent être dangereux pour les yeux et la peau;
- les appareils manifestement endommagés ne doivent pas être utilisés;
- l'appareil doit être débranché de l'alimentation avant de procéder au remplacement de la **lampe UV-C**;
- les portes et les panneaux d'accès qui portent le symbole de danger de rayonnement ultraviolet et dont l'**éclairement spectral UV-C** peut être supérieur à $1,7 \mu\text{W}/\text{cm}^2$ sont

équipés d'un interrupteur de verrouillage qui permet de couper l'alimentation des **lampes UV-C** à des fins de sécurité. Ne pas déroger à cette recommandation;

- avant d'ouvrir les portes et les panneaux d'accès destinés à l'**entretien par l'utilisateur** portant le symbole de danger de rayonnement ultraviolet, il est recommandé de déconnecter l'alimentation;
- il convient de ne pas enlever les **barrières UV-C** portant le symbole de danger de rayonnement ultraviolet;
- pour les appareils équipés de **lampes UV-C**, des informations sur le remplacement des **lampes UV-C** doivent être fournies, notamment le modèle et/ou le numéro de référence;
- lorsqu'ils sont installés sur place, les **systèmes de lampes germicides UV-C** spécifiés en usine et approuvés pour une utilisation avec l'appareil doivent être spécifiés dans les instructions par le numéro de modèle spécifique;
- ne pas utiliser de **lampes UV-C** à l'extérieur de l'appareil.

La conformité est vérifiée par examen.

7.111 Les appareils qui utilisent des **systèmes frigorifiques** dont la **pression maximale admissible** est supérieure à 7 MPa doivent comporter à portée de vue des accès de service le marquage suivant:

- le symbole ISO 7000-1701 (2004-01) qui comprend le texte "(X) MPa", où "X" n'est pas inférieur à la **pression maximale admissible**.

La conformité est vérifiée par examen.

8 Protection contre l'accès aux parties actives

L'article de la Partie 1 s'applique, avec les exceptions suivantes.

8.1.1 Addition:

Le calibre d'essai 18 de l'IEC 61032 n'est pas appliqué aux parties d'appareils qui, selon les instructions d'installation, doivent être montées à plus de 1,8 m du sol.

8.1.5 Addition:

En ce qui concerne les appareils qui comportent un panneau ou un couvercle d'installation spécifique qui ne peuvent pas être installés lorsque celui-ci n'est pas présent, la conformité est vérifiée selon le 5.10 (après installation conformément aux instructions d'installation).

9 Démarrage des appareils à moteur

L'article de la Partie 1 ne s'applique pas.

10 Puissance et courant

L'article de la Partie 1 s'applique.

11 Échauffements

L'article de la Partie 1 s'applique, avec les exceptions suivantes.

11.1 Addition:

Lorsque la température d'un enroulement de moteur dépasse la valeur spécifiée dans le Tableau 3 ou lorsqu'il existe un doute en ce qui concerne la classification du système d'isolation employé dans un moteur, la conformité est vérifiée par les essais de l'Annexe C.

11.2 Remplacement:

11.2.1 Les appareils sont installés dans un ou plusieurs locaux d'essai conformément aux instructions d'installation. En particulier:

- les **distances dans l'air** aux surfaces adjacentes spécifiées par le fabricant doivent être respectées;
- les dispositifs limiteurs réglables sont réglés à leur valeur maximale de coupure et au différentiel minimal admis par leurs dispositifs de réglage.

Pour les appareils équipés de **dispositifs de chauffage supplémentaires**, un caisson d'essai conforme à celui décrit au 11.2.5 est utilisé.

11.2.2 Pour les essais de chauffage des appareils raccordés à des **chauffe-air supplémentaires**, un conduit d'entrée est raccordé à l'entrée d'air de l'appareil (en admettant par hypothèse que l'appareil est conçu pour être utilisé de cette manière). Si des brides sont fournies, le conduit doit avoir les mêmes dimensions que celles-ci. Si des brides ne sont pas fournies, le conduit doit avoir les mêmes dimensions que l'ouverture d'entrée.

Un appareil qui comprend des **chauffe-air supplémentaires** ou qui est prévu pour l'installation de tels systèmes est raccordé à un conduit de sortie conforme à la Figure 102 a) ou à la Figure 102 b), selon la direction du débit d'air.

Le conduit d'entrée est équipé d'un dispositif de réduction réglable au moyen duquel le débit d'air peut être réduit.

Il convient que la réduction soit uniforme sur toute la section du conduit de façon que la totalité de la surface de chauffage soit exposée au débit d'air, sauf lorsque le conduit est fermé.

Pour les appareils sans conduit, d'autres moyens peuvent être utilisés pour restreindre uniformément l'entrée.

La distance entre l'ouverture de sortie d'air de l'appareil et le point le plus éloigné du conduit d'essai, perpendiculairement à l'ouverture de sortie, ne doit pas dépasser la valeur de:

- pour les appareils à flux ascendant, $(AB)^{0,5}$ indiquée à la Figure 102 a) ou la distance minimale spécifiée par le fabricant, si cette valeur est plus faible;
- pour les appareils à flux descendant, $300 + (AB)^{0,5}$ indiquée à la Figure 102 b) ou la distance minimale spécifiée par le fabricant, si cette valeur est plus faible.

NOTE 101 Pour les produits à conduits horizontaux, voir Figure 102 b), tournés de 90° dans le sens inverse des aiguilles d'une montre.

NOTE 102 Les appareils, peuvent être spécifiés par le fabricant pour une utilisation dans des applications dans lesquelles l'espace est limité pour l'appareil et les conduits connectés.

EXEMPLE 101 Pour les appareils à flux ascendant destinés à être utilisés dans des maisons préfabriquées (mobiles), la hauteur combinée de l'appareil et des conduits est généralement limitée à 2,1 m (7 pi) moins la distance dans l'air spécifiée par rapport aux matériaux combustibles.

EXEMPLE 102 Pour les appareils à flux descendant destinés à être utilisés dans des maisons préfabriquées (mobiles), la distance entre l'ouverture de sortie d'air et le point le plus éloigné du conduit d'essai, perpendiculairement à l'ouverture de sortie, est généralement réduite à au moins $25,4 + (AB)^{0,5}$.

11.2.3 *Un appareil raccordé qui ne comporte pas de **chauffe-air supplémentaires**, est monté avec un conduit de sortie dimensionné pour s'adapter aux brides de l'enveloppe ou aux ouvertures sans brides ou aux endroits prévus pour des brides. En outre, ce conduit doit évacuer l'air à distance de l'entrée d'air de retour.*

Le conduit de sortie d'air chaud est équipé d'un dispositif de réduction qui permet d'obtenir la pression statique maximale spécifiée dans les instructions.

11.2.4 Pour l'évaluation et l'essai des **unités partielles**, le montage d'essai et les conditions d'essai suivants doivent être respectés:

- les **unités d'évaporateur** et les **unités de condenseur** sont soumises à l'essai en tant qu'unités distinctes à la température ambiante maximale spécifiée dans les instructions. Lorsque ces températures ne sont pas indiquées dans les instructions, ces unités doivent être soumises à l'essai à une température ambiante égale à la température du point de rosée saturée du fluide frigorigène à la **pression maximale admissible** marquée ($\pm 0,1$ MPa) moins 10 K (± 1 K);
- les **unités de condensation** sont soumises à l'essai uniquement en mode refroidissement, à la température ambiante maximale spécifiée avec un sous-refroidissement de 9 K (± 1 K) et à la pression d'évaporation maximale spécifiée avec une surchauffe de 11 K (± 1 K). Pour les **unités de condensation** équipées d'un ou de plusieurs dispositifs d'expansion, la surchauffe/le sous-refroidissement doit être sous le contrôle normal des dispositifs d'expansion;
- les **unités d'évaporation** destinées uniquement au refroidissement sont soumises à l'essai en mode refroidissement uniquement à une pression de condensation égale à la **pression maximale admissible** marquée ($\pm 0,1$ MPa) avec un sous-refroidissement de 9 K (± 1 K);
- les **unités d'évaporation** destinées au fonctionnement en cycle inverse sont soumises à l'essai uniquement en mode chauffage, à la pression maximale d'évaporation spécifiée.

NOTE 101 Les essais en ce qui concerne les **unités de condensation** et les **unités d'évaporation** exigent le raccordement à un support calorimétrique ou à un dispositif analogue capable de contrôler les conditions d'entrée et de sortie du fluide frigorigène comme cela est spécifié dans l'essai ci-dessus. Les **unités de condenseur** et les **unités d'évaporateur** n'exigent pas de support calorimétrique ou de dispositif analogue.

11.2.5 *Le caisson d'essai est réalisé en contreplaqué d'une épaisseur d'environ 20 mm, avec les surfaces internes peintes en noir mat et tous les raccords étanches. Les distances entre le caisson et les surfaces de l'appareil et le conduit de sortie éventuel sont égales aux distances dans l'air minimales spécifiées dans les instructions.*

Lorsqu'aucune distance dans l'air minimale n'est spécifiée pour l'installation de l'appareil, l'appareil et le conduit de sortie doivent être enveloppés étroitement dans un matériau isolant à base de fibre de verre dont l'épaisseur est d'au moins 25 mm et la masse volumique d'au moins 16 kg/m³ au lieu d'utiliser le caisson d'essai en contreplaqué en contact direct avec l'appareil, et les thermocouples doivent être placés en contact direct avec l'enveloppe.

11.3 *Modification:*

Remplacer le premier alinéa par:

Les températures autres que celles des enroulements sont déterminées au moyen de thermocouples dont la taille, le choix et la position sont tels qu'ils ont l'effet le plus faible sur la température de la partie en essai.

NOTE 101 Les thermocouples dont le diamètre des fils est inférieur ou égal à 0,3 mm sont généralement réputés avoir un effet minimal sur la température lors du mesurage de petites parties telles que des composants électroniques.

Addition:

Les températures dans le conduit doivent être mesurées au moyen d'une grille de thermocouples constituée de neuf thermocouples de longueur identique et placés en parallèle de façon à former une grille, avec un thermocouple placé au centre de chacune des neuf surfaces de conduit identiques, dans un plan perpendiculaire au débit d'air. Pour les appareils sans conduit, la grille de thermocouples doit être située à moins de 25 mm de l'ouverture de sortie d'air et perpendiculairement à cette ouverture. La température de l'air mesurée au moyen de la grille de thermocouples ne doit pas dépasser 92 °C.

11.4 Remplacement:

Les appareils sont mis en fonctionnement dans les conditions de **fonctionnement normal** à une tension d'alimentation comprise entre 0,94 fois la **tension assignée** la plus basse et 1,06 fois la **tension assignée** la plus élevée, en choisissant la tension qui donne le résultat le plus défavorable.

11.5 Le paragraphe de la Partie 1 ne s'applique pas.

11.6 Le paragraphe de la Partie 1 ne s'applique pas.

11.7 *Addition:*

Lorsque l'appareil peut fonctionner soit en mode refroidissement soit en mode chauffage, un essai est effectué pour chacun des deux modes.

Les appareils équipés d'un dispositif de dégivrage sont également soumis à un essai de dégivrage dans les conditions les plus défavorables.

Tous les appareils sont mis en fonctionnement en continu jusqu'à l'établissement des conditions de régime, à l'exception des essais de dégivrage.

Les appareils sont utilisés en **fonctionnement normal** avec des débits qui donnent le résultat le plus défavorable.

NOTE 101 Les débits d'air ou de liquide, les températures de l'air ou du liquide, la pression statique (de l'air), les conditions de fonctionnement du compresseur, etc. peuvent être pris en considération.

11.8 *Addition:*

Les températures ne doivent pas dépasser la limite de température calculée à l'aide de la formule suivante:

$$\text{Limite de température [°C]} = 25 \text{ °C} + \text{valeur du Tableau 3} \quad (101)$$

NOTE 101 La Formule (101) permet de calculer la limite de température à partir de l'échauffement défini dans le Tableau 3.

Tableau 3 – Échauffements normaux maximaux

Modification:

À la première ligne, remplacer "Enroulements" par "Enroulements autres que ceux des motocompresseurs hermétiques".