

INTERNATIONAL STANDARD



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



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COMMENTED VERSION

INTERNATIONAL STANDARD



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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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CONTENTS

FOREWORD	5
INTRODUCTION	8
1 Scope	9
2 Normative references	10
3 Terms and definitions	12
4 General requirement	20
5 General conditions for the tests	20
6 Classification	21
7 Marking and instructions	21
8 Protection against access to live parts	28
9 Starting of motor-operated appliances	28
10 Power input and current	28
11 Heating	29
12 Void	35
13 Leakage current and electric strength at operating temperature	35
14 Transient overvoltages	36
15 Moisture resistance	36
16 Leakage current and electric strength	37
17 Overload protection of transformers and associated circuits	37
18 Endurance	37
19 Abnormal operation	37
20 Stability and mechanical hazards	45
21 Mechanical strength	45
22 Construction	46
23 Internal wiring	60
24 Components	61
25 Supply connection and external flexible cords	62
26 Terminals for external conductors	62
27 Provision for earthing	62
28 Screws and connections	62
29 Clearances, creepage distances and solid insulation	62
30 Resistance to heat and fire	63
31 Resistance to rusting	64
32 Radiation, toxicity and similar hazards	64
Annexes	73
Annex D (normative) Thermal motor protectors	73
Annex I (normative) Motors having basic insulation that is inadequate for the rated voltage of the appliance	73
Annex AA (informative) Examples for operating temperatures of the appliance	74
Annex BB (normative) Selected information about refrigerants	75
Annex CC (informative) Transportation, marking and storage for units that employ flammable refrigerants	79

Annex DD (normative) Requirements for ~~operation, service and~~ installation, ~~service, maintenance and repair, and decommissioning~~ manuals of appliances using flammable refrigerants	80
Annex EE (normative) Pressure tests.....	92
Annex FF (normative) Leak simulation tests	95
Annex GG (normative) Charge limits, ventilation requirements and requirements for secondary circuits	97
Annex HH (informative) Competence of service personnel.....	138
Annex II (Void).....	141
Annex JJ (normative) Allowable openings of relays and similar components to prevent ignition of A2L refrigerants	142
Annex KK (normative) Test method for hot surface ignition temperature for A2L.....	144
Annex LL (normative) Refrigerant detection systems for ~~A2L~~ flammable refrigerants	148
Annex MM (normative) Refrigerant sensor location confirmation test.....	160
Annex NN (normative) Flame arrest enclosure verification test for A2L refrigerants	164
Annex OO ~~(normative) UV radiation conditioning~~ (Void)	166
Annex PP (normative) Leak detection system confirmation test for flammable refrigerants	167
Annex QQ (normative) Methods for determining releasable charge	173
Bibliography.....	181
List of comments.....	183
Figure 101 – Example of label for field charged units	66
Figure 102 – Arrangement for heating test of appliances with supplementary air heater.....	70
Figure 103 – Supply circuit for locked-rotor test of a motor of the single-phase type – Revise as needed for three-phase test.....	71
Figure 104 – Power spectral density profile for vibration test in 21.101	71
Figure 105 – Dimensional details for the weight in the area of the pressure ball	72
Figure 106 – Measurement before and after the test.....	72
Figure GG.1 – Unventilated area	133
Figure GG.2 – Mechanical ventilation	134
~~Figure GG.3 – Isosceles triangle arrow test gauge~~	~~135~~
~~Figure GG.4 – Measurement of vibration amplitude~~	~~136~~
Figure GG.53 – Relevant heights h_{inst} , h_0 and h_{rel} for calculation of A_{min} and m_{max}	136
Figure GG.64 – Airflow direction	137
Figure KK.1 – Front view of test apparatus labels.....	144
Figure KK.2 – Test apparatus with dimensions	145
Figure KK.3 – Top view of test apparatus.....	146
Figure LL.1 – Example of test chamber design	155
Table 101 – Power spectral density profile for vibration test	46
Table ~~101~~ 102 – UVC spectral irradiance measurement location.....	65
Table AA.1 – Examples for operating temperatures of the appliance	74
Table BB.1 – Selected information about refrigerants	75
Table DD.1 – Mandatory clauses in each manual	80

Table GG.1 – Outline of Annex GG (informative)	97
Table GG.2 – Circulation airflow	104
Table GG.3 – Appliance with packaging	112
Table GG.4 – Appliance without packaging	112
Table GG.5 – Minimum ~~airflow~~ air velocity	128
Table GG.6 – Refrigerant leak rate ($\dot{m}_{\text{leak}}$)	131
Table LL.1 – Relationship among alarm set point, tolerance and test gas (informative)	151
Table LL.2 – Gas and vapour concentrations	153
Table LL.3 – Example of the test chamber design	156

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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.
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This commented version (CMV) of the official standard IEC 60335-2-40:2022 edition 7.0 allows the user to identify the changes made to the previous IEC 60335-2-40:2018 edition 6.0. Furthermore, comments from IEC SC 61D experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

IEC 60335 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 seventh edition cancels and replaces the sixth edition published in 2018. This edition constitutes a technical revision.

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

- Clause 1 – added **thermoelectric heat pumps** to the scope and increased maximum **rated voltage** to 300 V for single phase appliances;
- Clause 7 – revised requirements for marking on the appliance and packaging, including a symbol for minimum floor area and modifying the symbol for **flammable refrigerants** to include the safety group per ISO 817;
- Clause 11 and Clause 19 – restructured for alignment with Part 1 and added requirements for **supplementary air heaters**;
- Clause 13 and Clause 16 – revised requirement for leakage current for **stationary class I motor-operated appliances**;
- Clause 21 – added requirements for **particle foam material** and revised requirements for transport testing;
- Clause 22 – removed limit on the sum of **refrigerant charges** for appliances with multiple **refrigerating systems**, and revised requirements for avoiding ignition sources, **leak detection systems**, **safety shut-off valves**, and **particle foam material**;
- Clause 23 – added requirements to avoid contact between wires and refrigerant piping;
- Clause 24 – revised requirements for motor-compressors;
- Clause 30 – added requirements for resistance to heat of **particle foam material**;
- Annex BB – revised Table BB.1 with refrigerant information and added a link to ISO 817 refrigerant data;
- Annex DD – revised requirements for information in the manual for appliances with **flammable refrigerants**;
- Annex EE – revised requirements for pressure testing;
- Annex FF – revised requirements for leak simulation tests;
- Annex GG – added requirements for applying **releasable charge**, added additional coverage for A2 and A3 refrigerants, including new charge limits for appliances with **circulation airflow** and for **enhanced tightness refrigerating systems**, and revised requirements for **enhanced tightness refrigerating systems** using **A2L refrigerant**;
- Annex LL – revised requirements for **refrigerant detection systems**;
- Annex MM – revised simulated leak rate;
- Annex OO – deleted annex for conditioning internal wiring using UV light.
- Annex PP – new coverage of **leak detection system** confirmation test;
- Annex QQ – new coverage of method for determining **releasable charge**.

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

Draft	Report on voting
61D/491/FDIS	61D/493/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.

This part 2-40 is to be used in conjunction with IEC 60335-1:2010, its Amendment 1:2013 and its Amendment 2:2016. **1**

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: Safety 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 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).

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.

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

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

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

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 ~~may~~ 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 ~~and generic standards~~ 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. ~~For example, in the case of temperature requirements for surfaces on many appliances, generic standards, such as ISO 13732-1 for hot surfaces, are not applicable in addition to Part 1 or part 2 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.

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**, ~~including 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** **2** and **partial units**. Their maximum **rated voltage** being not more than ~~250~~ 300 V for single phase appliances and 600 V for ~~all other~~ multi-phase appliances. **3** ~~Partial units are within the scope of this International Standard.~~

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

The appliances referenced above ~~may~~ can consist of one or more factory-made assemblies. If provided in more than one assembly, the separate assemblies are ~~to be~~ 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 refrigerating safety are covered by ISO 5149-1, ISO 5149-2, and ISO 5149-3.~~ 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 ~~classification, A2L~~. **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.

~~This standard specifies particular requirements for the use of flammable refrigerants.~~

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 prescribe the criteria to ensure competence of persons during installation, servicing and disposal. Safety requirements during disposal are not specified in this standard. **4**

NOTE 103 Annex HH provides informative requirements on competence of persons. Criteria for competence of personnel for the purpose of certification schemes can be found in ISO 22712¹.

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,

¹ Under preparation. Stage at the time of publication: ISO FDIS 22712:2022

- 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 403104 Attention is drawn to the fact that

- for appliances intended to be used in vehicles or on-board ships or aircraft, additional requirements ~~may~~ can be necessary;
- ~~• for appliances subjected to pressure, additional requirements may 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.

NOTE 404105 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 60079-14:2013, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*

IEC 60079-15:2010, *Explosive atmospheres – Part 15: Equipment protection by type of protection "n"*

IEC 60335-2-34:2012, *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 61032, Protection of persons and equipment by enclosures – Probes for verification~~

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

ISO 817, *Refrigerants – Designation and safety classification*

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

ISO 1302:2002², *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 4892-2, Plastics – Methods of exposure to laboratory light sources – Part 2: Xenon arc lamps~~

~~ISO 4892-4, Plastics – Methods of exposure to laboratory light sources – Part 4: Open-flame carbon-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 5151:2017, *Non-ducted air conditioners and heat pumps – Testing and rating for performance*

ISO 5151:2017/AMD1:2020

ISO 7010:2011~~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 13355:2016, *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*

² Withdrawn.

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

~~ASTM D4728-06:2012, Standard Test Method for Random Vibration Testing of Shipping Containers~~

~~CAN/CSA C22.2 No. 0.17, Evaluation of Properties of Polymeric Materials~~

~~UL 746A, Standard for Polymeric Materials – Short Term Property Evaluations~~

~~UL 746B, Standard for Polymeric Materials – Long Term Property Evaluations~~

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.

3.1.9 Replacement:

normal operation

conditions that apply when the appliance is mounted or installed as in normal use and is operating under the most severe operating conditions specified by the manufacturer

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**. **5**

3.8.101

particle foam material

closed cell material moulded from thermoplastic particles (e.g. beads) with expanding agent **6**

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 ~~may~~ 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** 7

3.114.1

supplementary heater

electric heater ~~provided as part of the appliance to supplement or replace the output of the refrigerant circuit of the appliance by operation in conjunction with, or instead of, the refrigerating circuit~~ 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 ~~either~~ in a secured location with restricted access (e.g. machine rooms, rooftop and the like, or at a level ~~not less than~~ above 2,5 m ~~or in secured rooftop areas~~)

3.119

hydronic fan coil unit

factory-made assembly which provides the function of forced circulation of air for heating and/or cooling, which may 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 ~~class~~ 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 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

~~limit to the refrigerating system operating pressure, generally~~ the maximum pressure for which the equipment is designed, as specified by the manufacturer **8**

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 may 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 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 ~~responds~~ gives an output signal in response to a pre-set concentration of refrigerant in the environment

Note 1 to entry: A **refrigerant detection system** may have multiple ~~sensing elements~~ **refrigerant sensors**. 9

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, definition 3.7.7, modified – "of a substance" has been deleted]

3.140

hot surface ignition temperature

~~HSIT~~

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

3.141

A2L refrigerant

refrigerant ~~classified~~ classified as safety group A2L according to ISO 817

3.142

lower flammability limit

~~LFL~~

~~lower flammability limit according to ISO 817~~

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

~~potential ignition source~~

~~PIS~~

~~hot surfaces, flames and current-carrying devices which can be the source of arcing or sparking~~

~~Note 1 to entry: Examples of **potential ignition sources** are UV lights, electric heaters, pilot flames, brushed motors and similar devices. 10~~

3.146

circulation airflow

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

3.147 Void 11

~~ultraviolet radiation~~

~~optical radiation for which the wavelengths are shorter than those for **visible radiation**~~

~~Note 1 to entry: For ultraviolet (UV) radiation, the range between 100 nm and 400 nm is commonly subdivided into: UV-A, from 315 nm to 400 nm; UV-B, from 280 nm to 315 nm; and UV-C, from 100 nm to 280 nm.~~

~~[SOURCE: IEC 60050-845:1987, 845-01-05]~~

3.148 Void

~~optical radiation~~

~~electromagnetic radiation at wavelengths between the region of transition to X-rays ($\lambda \approx 1$ nm) and the region of transition to radio waves ($\lambda \approx 1$ mm)~~

~~[SOURCE: IEC 60050-845:1987, 845-01-02]~~

3.149 Void

~~visible radiation~~

~~any optical radiation capable of causing a visual sensation directly~~

~~Note 1 to entry: There are no precise limits for the spectral range of visible radiation since they depend upon the amount of radiant power reaching the retina and the responsivity of the observer. The lower limit is generally taken between 360 nm and 400 nm and the upper limit between 760 nm and 830 nm.~~

~~[SOURCE: IEC 60050-845:1987, 845-01-03]~~

3.150

UV-C lamp

source made to produce ~~optical~~ ultraviolet radiation for which the wavelengths are shorter than those for ~~visible radiation~~ and in the range of 100 nm to 280 nm wavelengths including **germicidal lamps**

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

3.151 Void

~~germicidal lamp~~

~~low pressure mercury vapour lamp with a bulb which transmits the bactericidal ultraviolet C radiation~~

~~[SOURCE: IEC 60050-845:1987, 845-07-53]~~

3.152

UV-C germicidal lamp system

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

Note 1 to entry: **UV-C germicidal ultraviolet radiation 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 ~~may~~ 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 **12**

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** **13**

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 **14**

EXAMPLE 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 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** **15**

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 **16**

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 may 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.

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 Clauses 11, 19 and 21 shall require that pressure measurements be made at various points in the **refrigerating system**.*

~~*At least one additional specially prepared sample is required for the tests of Annex FF (Leak simulation tests), if that test option is selected.*~~

NOTE 101 For reference purposes, the temperatures on the refrigerant piping ~~should~~ 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 tests of Annex LL are carried out, ~~at least two~~ additional **refrigerant sensors** are needed.*

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

~~*Due to the potentially hazardous nature of the tests of Clause 21 and Annexes EE and FF, special precautions need to be taken when carrying out the tests.*~~

Tests of Clause 15 may be conducted on a separate sample. The test of Subclauses 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 ~~Replacement~~ Addition:

The tests and test conditions of Clauses 10 and 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-~~package~~ units, the refrigerant lines shall be installed in accordance with the installation instructions. The length of 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. **17** The thermal insulation of the refrigerant lines shall be applied in accordance with the installation instructions.*

~~**5.101** Motor compressors are also subjected to the relevant test of Clause 19 of IEC 60335-2-34:2012, unless the motor compressor complies with that standard, in which case it is not necessary to repeat these tests.~~

~~**5.102** Motor compressors that are tested and comply with IEC 60335-2-34 need not be additionally tested for Clause 21. **18**~~

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 ~~and the relevant tests~~.

7 Marking and instructions

This clause of Part 1 is applicable except as follows.

7.1 Modification: **19**

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 ~~number~~ designation in accordance with ISO 817;
- ~~permissible excessive operating pressure~~ **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 ~~permissible excessive operating pressure~~ **maximum allowable pressures** for the suction and discharge side differ, a separate ~~indication~~ marking is required;
- for **pre-charged pipe sets**
 - refrigerant ~~number~~ 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; **20**
- 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.

~~For appliances using flammable refrigerants, the flame symbol ISO 7010-W021 (2011-05) and the operator's manual symbol described in 7.6 shall be visible when viewing the appliance after it has been installed. The marking may be behind a detachable part that has to be detached before maintenance or repair work. The perpendicular height of the triangle used for the symbol shall be at least 30 mm. For appliances that are not single packaged units, the required markings shall be provided on all indoor and outdoor units which complete the refrigerating system when installed. When an A2L refrigerant is used, the flame symbol ISO 7010-W021 (2011-05) shall be replaced with the A2L symbol described in 7.6.~~

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

~~If a flammable refrigerant is used, an additional warning symbol (flame symbol: ISO 7010-W021 (2011-05)) shall be placed on the nameplate of the unit near the declaration of the refrigerant type and charge information. The perpendicular height of the symbol shall be at least 10 mm, and the symbol need not be in colour. When an A2L refrigerant is used, the flame symbol ISO 7010-W021 (2011-05) shall be replaced with the A2L symbol described in 7.6.~~

~~The following warning shall also be applied to the non-fixed appliance when a flammable refrigerant is employed. The warning shall be placed on the outside of the appliance such that it is visible when in service for non-fixed appliance.~~

WARNING

~~Appliance shall be installed, operated and stored in a room with a floor area larger than 'X' m².~~

~~The minimum room size X shall be specified on the appliance. The X in the marking shall be determined in m² according to Annex GG; the marking shall not be required if the refrigerant charge (m_c) of the appliance is up to m_1 according to GG.1.2.~~

~~NOTE 101 For the refrigerating system, if the maximum allowable pressure of the low-pressure side and the high-pressure side is the same, a single indication is permitted.~~

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 the symbol need not 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. ~~When an A2L refrigerant is used, the flame symbol ISO 7010-W021 (2011-05) shall be replaced with the A2L symbol described in 7.6.~~

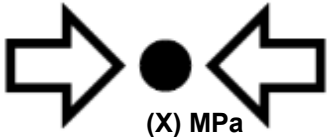
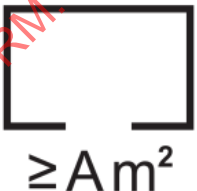
If a **flammable refrigerant** is used, the symbols for "read operator's manual" (symbols ISO 7000-0790 (2004-01)) and "service indicator; read technical manual" (ISO 7000-1659 (2004-01)) shall be placed on the appliance in locations visible to the persons required to know the information. The height 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; ~~operating instructions symbol~~", ~~ISO 7000-1641~~ ISO 7000-0790 (2004-01). Where: "X" is the **maximum allowable pressure**.

~~Where: "X" is not less than the maximum allowable pressure as determined in Annex EE.~~

7.6 Addition:

	A2L-symbol	warning; low burning velocity material
	[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] 21	warning; flammable material
	[symbol ISO 7000-1701 (2004-01)]	pressure
	[symbol IEC 60417-6040 (2010-08)]	ultraviolet radiation, instructional safeguard
	[symbol ISO 7000-1641 (2004-01)]	operator's manual; operating instructions
	[symbol IEC 60417-6412 (2019-03)] 22	minimum room floor area

7.12 Addition:

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

For ~~appliances using flammable refrigerants~~, an installation, service and operation manual, either separate or combined manuals, shall be provided and include the information given in Annex DD.

7.12.1 Addition:

In particular, the following information shall be supplied:

- a) that the appliance shall be installed in accordance with national wiring regulations;
- 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; **23**
- 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 which shall state that the vent shall not be obstructed.

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**, an installation manual, service, maintenance and repair manual, and decommissioning manual, either as separate or combined manuals, 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 ~~product~~ **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 assure 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 ~~refrigerant detecting~~ **leak detection system**, the instructions or unit markings shall contain the substance of the following:

"This unit is equipped with a ~~refrigerant leak detector~~ **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 ~~supplemental unit~~ remote located **refrigerant sensor** is employed to detect leaked refrigerant, such ~~unit~~ 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 ~~ventilation~~ **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 ~~supplemental~~ **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 ~~manufacturer~~ 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 ~~in each of the following conditions~~ on the packaging of the appliance if the appliance is charged with refrigerant.

- ~~— on the packaging of the appliance if the appliance is charged with refrigerant excluding appliances with **A2L refrigerant charge** not exceeding m_1 ;~~
- ~~— when viewing the appliance on display for sale. This does not apply to appliances using **A2L refrigerants**.~~

~~For appliances that are not **factory sealed single packaged units**, the required markings shall be provided on all indoor and outdoor units which complete the **refrigerating system**.~~ **24**

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 ~~may~~ can result in the escape of dangerous UV-C radiation. UV-C radiation may, 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 ~~may~~ 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 ~~subject product~~ 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 ~~For~~ Appliances employing **refrigerating systems** with **maximum allowable pressures** greater than 7 MPa, ~~the instructions shall include the substance of~~ shall be marked within sight of the refrigerant service ports with the following:

- ~~— **WARNING: System contains refrigerant under very high pressure. The system must be serviced by qualified persons only.**~~
- 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.

8.1.5 Addition:

~~As regards the products~~ 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 ~~as instructed in~~ according to the installation ~~manual~~ 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 ~~replaced by the following~~ applicable except as follows.

11.1 Addition:

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

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

~~Nevertheless,~~ 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;
- ~~– flow rates for liquid source or sink equipment shall be the minimum specified in the instructions except for hydronic fan coil units where the flow rates and liquid temperatures shall be the maximum specified in the instructions;~~
- ~~– the outlet duct connected to the appliance shall be subjected to the maximum static pressure given in the instructions;~~
- ~~– for appliances provided with means of adjusting the flow, the flow for the tests shall be the minimum obtainable;~~
- 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 11.92.5 is used.

11.2.12 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 ~~is~~ shall be the same size as the inlet opening.

An appliance that includes or has provision for **supplementary air heater** is fitted with ~~a metal~~ 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 value of: **25**

- 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 Figure 102b, rotated 90 degrees 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 1 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 2 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 $25,4 + (AB)^{0,5}$.

11.2.23 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.

11.2.34 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 Test casing

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/m^3 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 and NOTE 1 with:

Temperatures other than those of windings are determined by means of ~~fine-wire~~ thermocouples which are sized **26** 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 ~~be fine-wire thermocouples~~ have minimum effect on temperature when measuring small parts such as electronic components.

~~Thermocouples used for determining the temperatures of the surface of walls, ceiling and floor are embedded in the surface or attached to the back of small blackened disks of copper or brass, 15 mm in diameter and 1 mm thick, which are flush with the surface.~~

~~So far as is possible, the appliance is positioned so that parts likely to attain the highest temperatures touch the disks.~~

~~In determining the temperatures of handles, knobs, grips and the like, consideration is given to all parts which are gripped in normal use and, if of insulating material, to parts in contact with hot metal.~~

~~The temperature 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 or reduction of clearances and creepage distances below the values specified in Clause 29.~~

~~Temperatures of windings are determined by the resistance method unless the windings are non-uniform or severe complications are involved in order to make the necessary connections, in which case the temperatures are determined by means of thermocouples.~~

11.3 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. **27**

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. ~~Heating elements shall be energized at a voltage which gives an electrical input of 1,15 times the maximum rated power input.~~

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

~~For appliances with supplementary heaters or provision for supplementary heaters, an additional test is conducted with all the heating elements operative by short circuiting thermostats or by reducing, if necessary, the air temperature to a value which causes all the elements to switch on.~~

This subclause of Part 1 is not applicable.

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

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. 28

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 temperatures are monitored continuously and shall not exceed the values shown in Table 3, protective devices shall not operate and sealing compound shall not flow out.~~

~~The temperature of the air in the outlet duct shall not exceed 90 °C.~~

~~The value of the temperature of a winding shall be calculated from the formula:~~

$$T = \frac{R_2}{R_1} (k + T_1) - k$$

~~where~~

~~T is the temperature of the copper winding at the end of the test;~~

~~R_1 is the resistance at the beginning of the test;~~

~~R_2 is the resistance at the end of the test;~~

~~T_1 is the ambient temperature at the beginning of the test;~~

~~k is equal to 234,5 for copper windings and 225 for aluminium windings.~~

~~At the beginning of the test, the windings shall be at ambient temperature.~~

~~It is recommended that the resistance of windings at the end of the test 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.~~

Table 3—Temperature limits

Parts	Temperature °C
~~Windings of sealed motor compressors^a~~	
~~— with synthetic insulation~~	140
~~— with other insulation~~	130
~~External enclosure of appliances with or without supplementary heaters~~	85
~~Windings^b if the winding insulation is (other than motor compressors):~~	
~~— of class 105 (A) material^c~~	100 (90)
~~— of class 120 (E) material^c~~	115 (105)
~~— of class 130 (B) material^c~~	120 (110)
~~— of class 155 (F) material^c~~	140
~~— of class 180 (H) material^c~~	165
~~— of class 200 material^c~~	185
~~— of class 220 material^c~~	205
~~— of class 250 material^c~~	235
~~Terminals, including earthing terminals, for external conductors of stationary appliances, unless they are provided with a supply cord~~	85
~~Ambient of switches, and thermostats and temperature limiters^d~~	
~~— without T marking~~	55
~~— with T marking~~	T
~~Rubber or polyvinyl chloride insulation of internal and external wiring, including supply cord:~~	
~~— without temperature rating^e~~	75
~~— with temperature rating (T)~~	T
~~Cord sheaths used as supplementary insulation~~	60
~~Rubber, other than synthetic, used for gaskets or other parts, the deterioration of which could affect safety:~~	
~~— when used as supplementary insulation or reinforced insulation~~	65
~~— in other cases~~	75
~~Lampholders with T marking^j~~	
~~— B15 and B22 marked T1~~	165
~~— B15 and B22 marked T2~~	210
~~— other lampholders~~	T
~~Lampholders without T marking^j~~	
~~— E14 and B15~~	135
~~— B22, E26 NS E27~~	165
~~— other lampholders and starter holders for fluorescent lamps~~	80
~~Material used as insulation other than that specified for wires and windings:~~	
~~— impregnated or varnished textile, paper or press board~~	95
~~— laminated, bonded with:~~	
~~• melamine formaldehyde, phenol formaldehyde or phenol furfural resins~~	110
~~• urea formaldehyde resin~~	90
~~— printed circuit boards bonded with epoxy resin~~	145
~~— moulding of:~~	
~~• phenol formaldehyde with cellulose fillers~~	110
~~• phenol formaldehyde with mineral fillers~~	90
~~• melamine formaldehyde~~	110
~~• urea formaldehyde~~	90
~~— polyester with glass fibre reinforcement~~	135
~~— silicone rubber~~	170
~~— polytetrafluoroethylene~~	290
~~— pure mica and tightly sintered ceramic material, when such materials are used as supplementary insulation or reinforced insulation~~	425
~~— thermoplastic material^f~~	—
~~Wood, in general^g~~	90

Parts	Temperature °C
Wooden walls of the test casing	90
Outer surfaces of capacitors ^h :	
— with marking of maximum operating temperature (T) ⁱ	T
— without marking of maximum operating temperature:	
• small ceramic capacitors for radio and television interference suppression	75
• capacitors complying with IEC 60384-14	75
• other capacitors	45
Handles, knobs, grips and the like and all parts which are gripped in normal use:	
— of metal	60
— of porcelain or vitreous material	70
— of moulded material, rubber or wood	85
Parts in contact with oil having a flash-point of t °C	t + 25
Any point where the insulation of wires can come into contact with parts of a terminal block or compartment for fixed wiring of a stationary appliance not provided with a supply cord:	
— if the instructions require the use of supply wires with temperature rating (T)	T
— in other cases	75
^a — Not required for motor compressors that comply with IEC 60335-2-34. ^b — The temperatures within parentheses apply when thermocouples are used. The figures without parentheses apply when the resistance method is used. ^c — The classification is in accordance with IEC 60085. — Examples of Class A (class 105) material are: — impregnated cotton, silk, artificial silk and paper; — enamels based on oleo or polyamide resins. — Examples of Class B (class 130) materials are: — glass fibre, melamine formaldehyde and phenol formaldehyde resins. — Example of Class E (class 120) material are: — mouldings with cellulose fillers, cotton fabric laminates and paper laminates, materials bonded with melamine formaldehyde, phenol formaldehyde or phenol furfural resins; — cross-linked polyester resins, cellulose triacetate films, polyethylene terephthalate films; — varnished polyethylene terephthalate textile bonded with oil modified alkyd resin varnish; — enamels based on polyvinyl formalin, polyurethane or epoxy resins. — For totally enclosed motors, the temperature limits for class A (class 105), class E (class 120) and class B (class 130) materials may be increased by 5 °C (5 K). — A totally enclosed motor is a motor so constructed that the circulation of the air between the inside and the outside of the case is prevented, but which is not necessarily sufficiently enclosed to be called airtight. ^d — T means the maximum operating temperature. — The ambient of switches and thermostats is the temperature of the air at the hottest point at a distance of 5 mm from the surface of the switch and thermostat concerned. — For the purpose of this test, switches and thermostats marked with the individual ratings may be considered as having no marking for the maximum operating temperature, if this is requested by the manufacturer of the appliance. However, if a thermostat or other temperature limiter is mounted on a heat conducting part, the declared temperature limit of the mounting surface (Ts) is also applicable. Therefore, the temperature of the mounting surface has to be measured. ^e — This limit applies to cables, cords and wires complying with the relevant IEC standards; for others, it may be different. ^f — There is no specific limit for thermoplastic material, which shall withstand the tests of 30.1, for which purpose the temperature shall be measured. ^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 which are short-circuited in 19.11.2 c). ⁱ — Temperature marking for capacitors mounted on printed circuit boards may be given in the technical sheet. ^j — Locations for measuring the temperatures are specified in Table 12.1 of IEC 60598-1:2008. If these or other materials are used, they shall not be subjected to temperatures in excess of the thermal capabilities as determined by aging tests made on the materials themselves.	

~~NOTE 101 The temperature limit for metal applies to parts having a metal coating at least 0,1 mm thick and to metal parts having a plastic coating less than 0,3 mm thick.~~

~~NOTE 102 The temperature of the terminal's switches is measured if the switch is tested in accordance with Annex H.~~

Addition:

Temperatures shall not exceed the temperature limit according to this formula:

$$\text{Temperature limit } [^{\circ}\text{C}] = 25^{\circ}\text{C} + \text{Table 3 value } 29 \quad (101)$$

NOTE 101 Formula (101) calculates the temperature limit from the temperature rise as defined in Table 3.

Table 3 – Maximum normal temperature rises 30

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 (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	

~~11.9 Test casing~~

~~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 specified by the manufacturer.~~

~~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 may be wrapped closely around the appliance and the outlet duct, provided this is agreed with the manufacturer.~~

~~In that case, thermocouples are directly placed in contact with the enclosure.~~

12 Void

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**. **31** 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 may 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 11.6, and the tests of Clause 16.

*Following these tests, an inspection is made within the enclosures. The water which may have entered the enclosure shall not have reduced **clearances** and **creepage distances** below the minimum values specified in Clause 29.*

~~NOTE 101 Appliances designed to be installed completely inside a building and which have no outdoor parts are not subjected to the test of 15.2.~~

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-package 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 test

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. 32 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 ~~Replacement:~~

~~All ducted appliances provided with supplementary heaters are subjected to the following test under the conditions specified in Clause 11:~~

~~After the airflow conditions specified are established, the indoor airflow is restricted to such an extent that the temperature of the air in the outlet, measured by means of the thermocouple grid (see 11.3), is 3 K below the temperature obtained after a temperature limiting control, a motor protective device, a pressure switch or similar device operates for the first time as a result of slowly restricting the free area of the inlet.~~

~~This is achieved if the temperature rise is approximately 1 K per min.~~

~~It is necessary to restrict the free area of the inlet until the first of the protective devices operates and then operation is resumed with sufficient restriction so that the temperature of the discharge air is 3 K below the temperature at the moment of cut off.~~

~~Appliances are operated at rated voltage or at the upper limit of the rated voltage range.~~

~~To facilitate this test, the protective device which has operated shall be short-circuited once the temperature at which it operates has been determined, if necessary.~~

~~Non-ducted appliances provided with supplementary heaters are operated as specified in Clause 11. Thermal controls that operate during the test of Clause 11 are short circuited.~~

~~When steady conditions are established, the airflow rate is reduced until it is just sufficient to prevent a thermal cut out from operating.~~

~~Under these conditions, the appliance is again operated until steady conditions are established or for 1 h, whichever is longer.~~

~~After this period, the airflow is further restricted to verify that the thermal cut out operates.~~

Addition:

This subclause of Part 1 is not applicable for appliances with **supplementary air heaters**. **33**

19.3 ~~Replacement:~~

~~If all electric heating elements are not energized under the conditions specified in 19.2 for the air entering the evaporator, an additional test is carried out at a lower temperature of the inlet air, this temperature being the highest that will permit all electric heating elements to be energized.~~

~~It is the intention that the operating point be just below the point of maximum restriction of the air entering the indoor coil assembly thus permitting continuous operation of both the motor compressor and the electric heating elements. If the temperature of the air entering the evaporator required to permit all electric heating elements to be energized is less than the values specified, this lower temperature may be simulated by reducing the airflow through the evaporator, by blocking a part of the evaporator, or by similar means in order to obtain the~~

~~operating conditions which would occur at this lower temperature of the air entering the evaporator.~~

~~Appliances are operated at **rated voltage** or at the upper limit of the **rated voltage range**.~~

Addition:

*This subclause of Part 1 is not applicable for appliances with **supplementary air heaters**. 34*

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 ~~may~~ 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 60335-2-40, 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 IEC 60335-1, 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 60335-2-34:20122021, if applicable, and shall comply with the requirements in 19.104 of IEC 60335-2-34:20122021.

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. 35

19.11.4 Modification:

Add before the first paragraph:

The first paragraph of Part 1 is not applicable ~~for stand-by mode~~ 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** ~~has to~~ shall be tested individually with the appliance operated under **normal operation** at any temperature within the working range.

Components protected by a **protective electronic circuit** that ~~have~~ has been previously tested and shown to comply with the requirements of 19.11.4 of its standard need not to be retested in the final application, ~~if engineering judgement gives evidence that the test in the final application will not lead to a hazardous condition.~~ 36

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 ~~may~~ can be necessary to provide specially prepared component samples, e.g. compressors with locked rotor.

19.11.4.8 Modification:

Add to the first sentence:

"at any temperature within the working range."

19.13 Modification:

Table 9 – Maximum abnormal temperature rise

Addition: **37**

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 note:

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. ~~This condition is, achieved~~ 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 may 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** 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 ~~velocity~~ **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 Appliances with supplementary air heaters 38

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 Subclause 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 Clause 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 but except that an overshoot of 25 °C 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 hours, 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.

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. 39

Such pipes are not connected to the appliance during this test.

21 Mechanical strength

This clause of Part 1 is applicable except as follows.

21.1 Addition:

~~Safety requirements specified in ISO 5149-2 shall apply.~~

~~Safety requirements specified in Annex EE shall apply.~~

Pressure vessels shall comply with the requirements of ISO 5149-2:2014, Subclause 4.4.2. 40

The pressure test in Annex EE applies to parts other than **pressure vessels**.

21.2 Modification:

Add the following sentence after 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. 41*

21.101 Addition:

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 ~~ASTM D4728-06. Tests shall be run for a duration of 180 min~~ ISO 13355:2016 with the power spectral density profile specified in Table 101. 42

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 13355:2016 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. **43**

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 test 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.

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.

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.

~~NOTE 101 This requirement can be met by the provision of suitable drain holes.~~

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.

~~NOTE 101~~ No force ~~is~~ shall be applied to the conductor after it has been cut.

~~NOTE 102~~ This test ~~is~~ shall be made after the tests of Clause 29.

22.46 Modification:

Add the following after the 1st paragraph:

If the **protective electronic circuit** software is a part of the **normal operation** control, inspection of software shall be limited to relevant source code of safety controls or related software controls. ~~Alternative methods may be used if they demonstrate equivalent levels of safety.~~ **44**

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 Appliances provided with supplementary heaters

22.102.1 Appliances provided with **supplementary air heaters** ~~for air~~ 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.

~~NOTE~~ If, during the tests of Clause 19, a ~~self-resetting control~~ operates, it would be necessary to short out this control to determine if the ~~non-self-resetting thermal cut-out~~ then operates.

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 ~~permissible excessive operating~~ **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 %, ~~as a maximum~~, 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 ~~permissible excessive operating pressure~~ **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 ~~permissible excessive operating pressure~~ **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 ~~may~~ **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 **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.

22.112 The construction of the **refrigerating system** shall comply with the requirements of ISO 5149-2:2014, Subclauses 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 and ISO 5149-2:2014/AMD1:2020, Subclauses 4.1, 5.2.3, 5.2.9.2. **45**

~~Appliances using flammable refrigerants shall comply with the requirements and tests of Annex GG.~~

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 ~~tubing~~ piping shall be protected or enclosed to avoid mechanical damage. The ~~tubing~~ refrigerant piping shall be protected to the extent that it will not be handled or used for carrying during moving of the ~~product~~ appliance. ~~Tubing~~ Refrigerant piping located within the ~~confines of the cabinet~~ 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, ~~are not acceptable~~ 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) of all refrigerating systems within the appliance employing A2 and A3 refrigerants shall not exceed m_3 as defined in Annex GG.~~ **46**

The **refrigerant charge** (m_c) in each **refrigerating system** employing ~~A2L~~ **flammable refrigerant** shall not exceed m_3 as defined in Annex GG. **47**

The construction of the **refrigerating system** using **flammable refrigerants** shall comply with the requirements in Annex GG.

Compliance is checked by inspection.

22.116 Arcs and sparks from electric components 48

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 ~~and~~ or connected ducts where electrical components, which could be a source of ignition and which could function ~~under normal conditions or in the event of a leak, are fitted~~ 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.

~~Refrigerant pipes containing **A2L refrigerant** which connect **refrigerating system** components shall not be considered a source of leaked refrigerant for the purpose of evaluating potential for fire or explosion hazard relative to **potential ignition sources** within the appliance if the piping within the area of the appliance to be evaluated complies with all of the following:~~

- ~~• no connecting joints;~~
- ~~• no bends with centreline bend radius less than 2,5 times the external pipe diameter;~~
- ~~• protected from potential damage during **normal operation**, service or maintenance.~~

~~All electric components that could be a source of ignition and which could function under normal conditions or in the event of a leak, shall comply with at least one of the following:~~

- ~~• shall be located in an enclosure which complies with Clause 20 of IEC 60079-15:2010 for restricted breathing enclosures suitable for use with group IIA gases or the refrigerant used;~~
- ~~• shall not be located in an area where a potentially flammable gas mixture will accumulate as demonstrated by the test of Annex FF. Electrical components not located in an area where a potentially flammable gas mixture will accumulate as demonstrated by the test of Annex FF are not considered an **potential ignition source**;~~
- ~~• for **A2L refrigerants**, located in an enclosure which is in compliance with Annex NN.~~

~~Components and apparatus complying with Clause 16 to 22 of IEC 60079-15:2010, for group IIA gases or the refrigerant used or an applicable standard that makes electrical components suitable for use in Zone 2, 1 or 0 as defined IEC 60079-14 are not considered as a source of ignition.~~

NOTE 1 The test current for a switching component is the **rated current** of the component or the actual load to be switched, whichever is greater.

NOTE 2 **Potential ignition sources** can be electrical components which produce sparks or arcs or hot surfaces under normal conditions. Examples are brush type motors, light switches, relays, electric heaters, or UV lights.

~~For **A2L refrigerants**, electrical components in compliance with Annex JJ are not considered a **potential ignition source**.~~

*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, Clauses 7 through 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 Clause LL.11.*

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. **49**

- 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 incandive 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/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. **50**

22.116.4 For **A2L refrigerants**, devices capable of 100 000 cycles per Clause 24, switching ~~devices~~ AC loads in compliance with ~~all~~ one of the following are not considered a potential ignition source: **51**

~~— the device is capable of 100 000 cycles per Clause 24;~~

- for resistive loads where the impedance has a power factor higher than 0,99: Breaking current per contact is not more than 48A 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 (~~L_e~~) 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;
 - $L_e = 2,5 \times (6,7/S_u)^4$ ~~when breaking two legs of a three phase load, or when breaking one or two legs of a single phase load~~ 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 ~~may~~ 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 ~~Annex GG~~ 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 ~~allowable~~ 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 $21,0\% \pm 0,1\% \text{ O}_2$ excluding water vapour determined at the nominal composition as specified in ISO 817.

NOTE 3 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 Hot surfaces

22.117.1 Temperatures on surfaces that ~~may~~ 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 ~~flammable refrigerants except A2L~~ A2 and A3 refrigerants not listed in Annex BB, the maximum allowable surface temperature is ~~determined by the AIT reduced by 100 K~~. **52**

For **A2L refrigerants** not listed in Annex BB, the maximum allowable surface temperature is determined by the ~~highest~~ higher of ~~AIT reduced by 100 K~~ or, if tested per Annex KK, the **hot surface ignition temperature** reduced by 100 K, ~~but not higher than 700 °C~~. **53**

*Compliance is checked by measuring the appropriate surface temperatures during the tests of Clauses 11 and 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 Clause LL 11 are considered to comply with 22.117. **54**

22.117.2 Temperatures on surfaces that ~~may~~ 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 19.2, 19.3, 19.101 to 19.104~~ Clause 11. **55**

22.117.3 Open source 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 ~~may~~ 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 ~~When a flammable refrigerant is used, all appliances shall be charged with refrigerant at the manufacturing location or charged on site as recommended by the manufacturer.~~

~~A part of an appliance that is charged on site, which requires brazing or welding in the installation, shall not be shipped with a flammable refrigerant charge.~~ 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 ~~may~~ 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 assure 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 level 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 Leak detection system sensor location

22.121.1 For the installation condition of appliances using an **A2L refrigerant** and where a **refrigerant leak detection system** is applied to fulfil the requirements of Annex GG, ~~the refrigerant sensor of the system shall be located where leaking refrigerant is likely to stagnate.~~ or for the purpose of limiting **releasable charge**, the **refrigerant sensor** shall be: **56**

- 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, the **refrigerant sensor** may be 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
 - 10 m horizontal distance in line sight of the unit and on a wall within the room in which the unit is installed, or
 - 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 located

- 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 mechanical joints shall not require that **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. **57**

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 need 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. **58** 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 Clauses QQ.3 and 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. **58***

For installations with field applied joints which are exposed in the occupied space, these joints shall fulfil at least one of the following: **59**

- 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 Refrigerant detection systems that are required by this standard for A2L refrigerants shall comply with Annex LL.**~~

For **refrigerant detection systems** that are required by this standard for **flammable refrigerants**, the following applies: **60**

- 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** provides notification to the user that replacement of the **refrigerant sensor** is required, then resetting this notification shall only be possible when the **refrigerant sensor** has been replaced.

Refrigerant detection system shall comply with Annex LL.

Compliance is checked by inspection and tests according to Annex LL.

22.123 ~~For appliances connected via an air duct system to one or more rooms using an **A2L refrigerant**~~

- ~~— which include a separate section with refrigerant containing components except pipes (e.g. compressors, **condensers**), and~~
- ~~— which are isolated from the airflow and located in a room smaller than A_{min} per Clause GG.2,~~

~~then Clause GG.4 (ventilated enclosure) can be applied, where the required ventilation can be provided by the ventilation system. That section shall have an opening to the outdoor or indoor air stream to be able to ventilate the refrigerant to an area in compliance with Annex GG.~~

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. **61**

22.124 ~~If a **refrigerant detection system** is used, care has to be taken that in the event of a leak, accumulating refrigerant will be detected properly in every operating mode (e.g. indoor fan off).~~

~~*Compliance for sensors is checked by inspection and by testing in accordance with Annex MM. Remote located sensor location is not tested. Sensors located 100 mm or less directly below the unit are not considered remote sensors.*~~

Void **62**

22.125 **Refrigerating systems** that fulfil all of the following conditions ~~shall~~ may be considered **enhanced tightness refrigerating systems**:

- a) compressors, pressure relief devices ~~or~~ and **pressure vessels** ~~type refrigerant containing components~~ of the **refrigerating system** shall be located in locations other than the occupied space,

~~NOTE Pressure vessel means 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 a largest cross-sectional dimension not greater than 152 mm.~~

- 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) ~~systems where the equipment~~ **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 ~~better~~ **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 ISO 13256.
- 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 ~~UL 746B~~ **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-percent reduction of the unconditioned property values for items 1) to 4) below ~~when tested in accordance with CAN/CSA C22.2 No. 0.17 and UL 746A:~~

- 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. **63**

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 Subclause 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 $1,7 \mu\text{W}/\text{cm}^2$, 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 Subclause 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 Subclause 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** ~~plus~~ 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

Safety shut-off valves shall default to fully closed position when the appliance is de-energised for any reason other than failure of the supply mains. 64

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 hours. 65

For **refrigerating systems** using A2 or A3 refrigerants, **safety shut-off valves** shall be factory fitted in the appliance. 66

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} : 67

$$m_{sv} = 4 \times LFL \quad (102)$$

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 below test, 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 minute: 68

- $0,02 \times$ **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.

NOTE 5 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 6 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 second 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. **69**

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.

23 Internal wiring

This clause of Part 1 is applicable except as follows.

~~**23.101** Internal wiring that is exposed to direct or reflected UV-C radiation shall be UV-C resistant.~~

~~*Compliance is checked by the following test.*~~

~~*Samples of the internal wiring are conditioned in accordance with Annex OO.*~~

~~*On completion of the conditioning, the cable is wrapped in metal foil and is wound around a conductive mandrel 15 mm in diameter for three turns. A voltage of 2 000 V is applied for 15 min between the conductor and the mandrel. There shall be no breakdown.*~~ **70**

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 are not required to be separately tested according to IEC 60335-2-34, nor are they required to meet all requirements of IEC 60335-2-34 if they meet all requirements of 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. **71**

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
–	electromechanical proof of airflow control	100 000
–	self-resetting electrical pressure-limiting device	3 000
–	non-self-resetting electrical pressure-limiting device	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 2A or 2B;
- shall have a trip free mechanism of type 2J;
- 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 ~~they are~~ the **supply cord** with a plug is for indoor use only, ⁷²
- 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 ~~minimum~~ 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. [73](#)*

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 2 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, ~~in particular with Clauses 8 and 27~~, 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.

~~Addition:~~

32.101 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 ~~actual degree of exposure~~ **maximum exposure time of 60 min/day at 1,7 $\mu\text{W}/\text{cm}^2$ spectral irradiance**, **74** that the user would experience in performing his 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, $S_{UV} = 0,5$ at 254 nm as defined in IEC 62471 equals 0,85 $\mu\text{W}/\text{cm}^2$). ~~The exposure limit at 0,85 $\mu\text{W}/\text{cm}^2$ effective irradiance at this level is 60 min/day.~~

Compliance is determined by measuring the **UV-C spectral irradiance** per IEC 62471:2006, Clause 5 and Annex B.

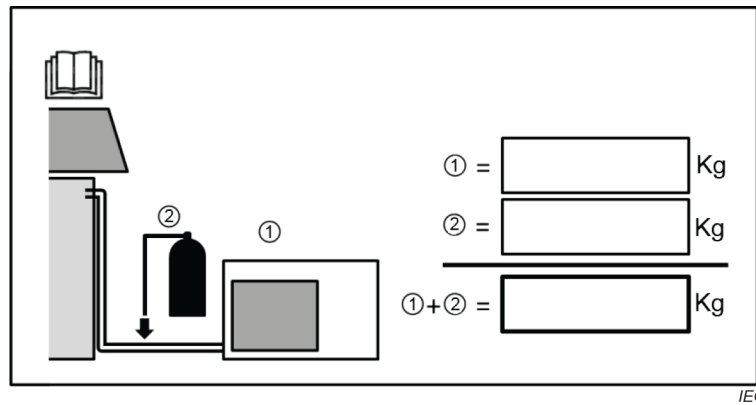
32.101.3 UV-C spectral irradiance shall be measured at the location indicated in Table ~~101~~**102**.

Table ~~101~~ 102 – UVC 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 per 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.



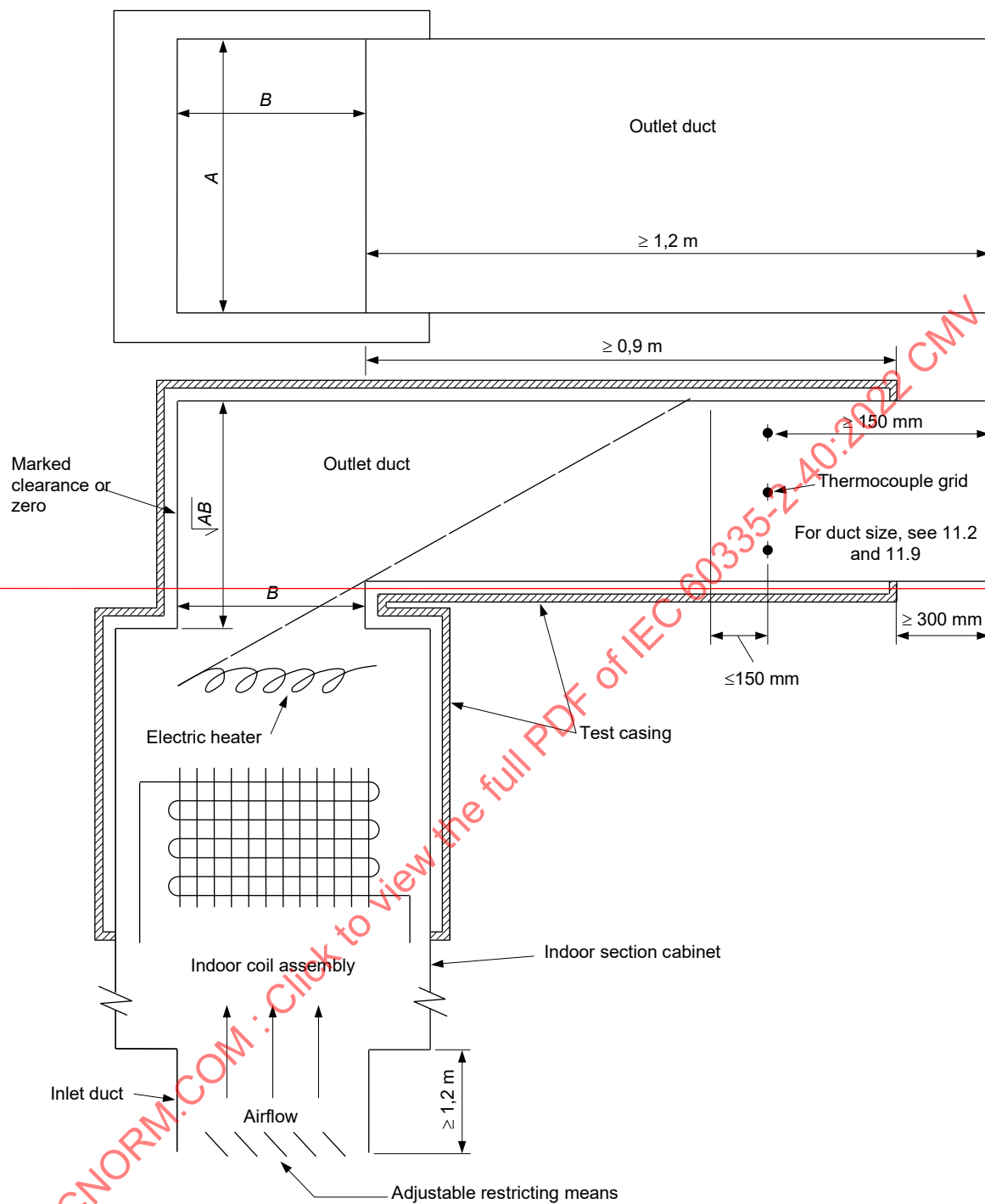
Key

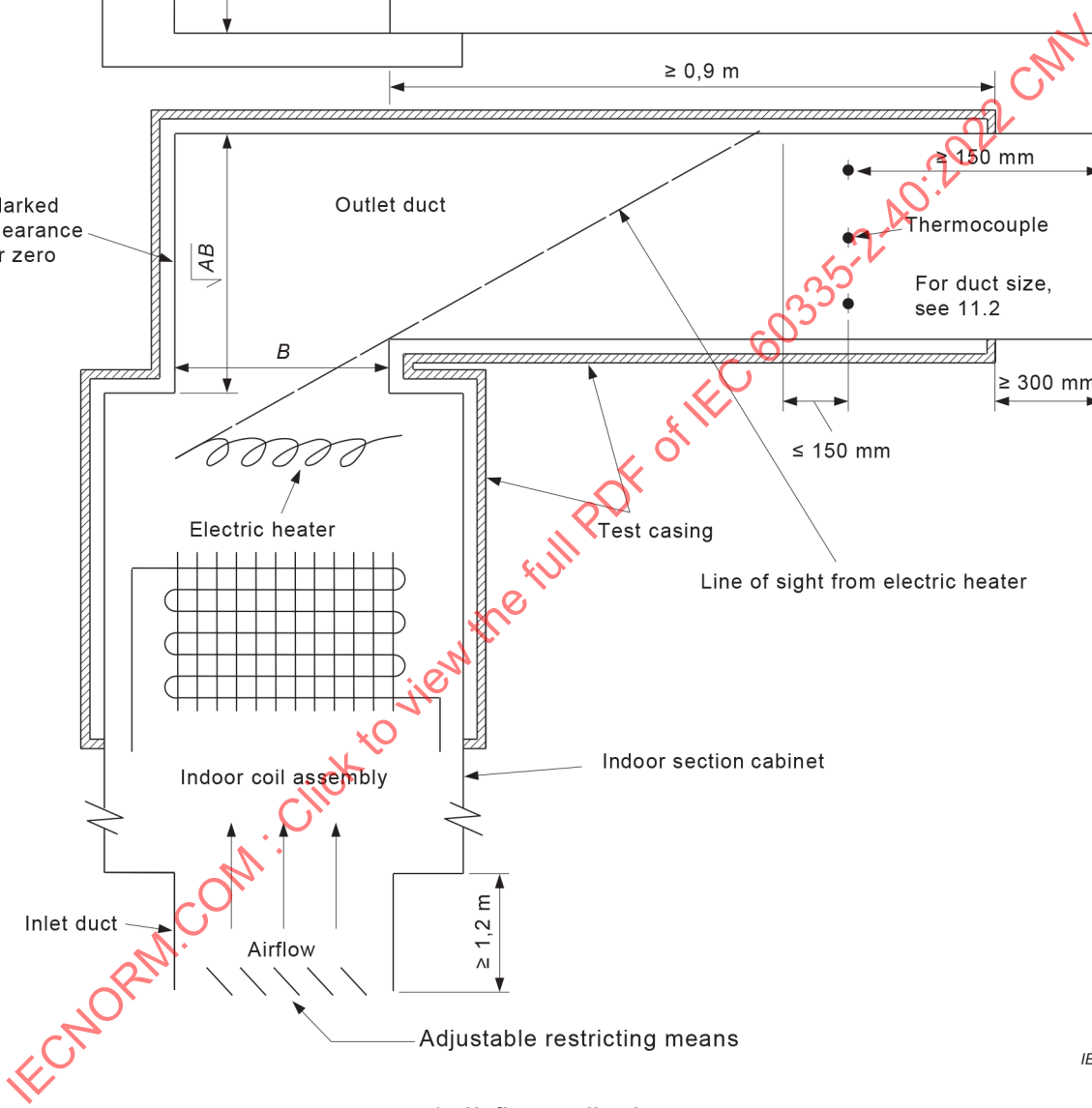
Example 1 **refrigerant charge** of the precharged part of the appliance

Example 2 **refrigerant charge** added during installation

Figure 101 – Example of label for field charged units

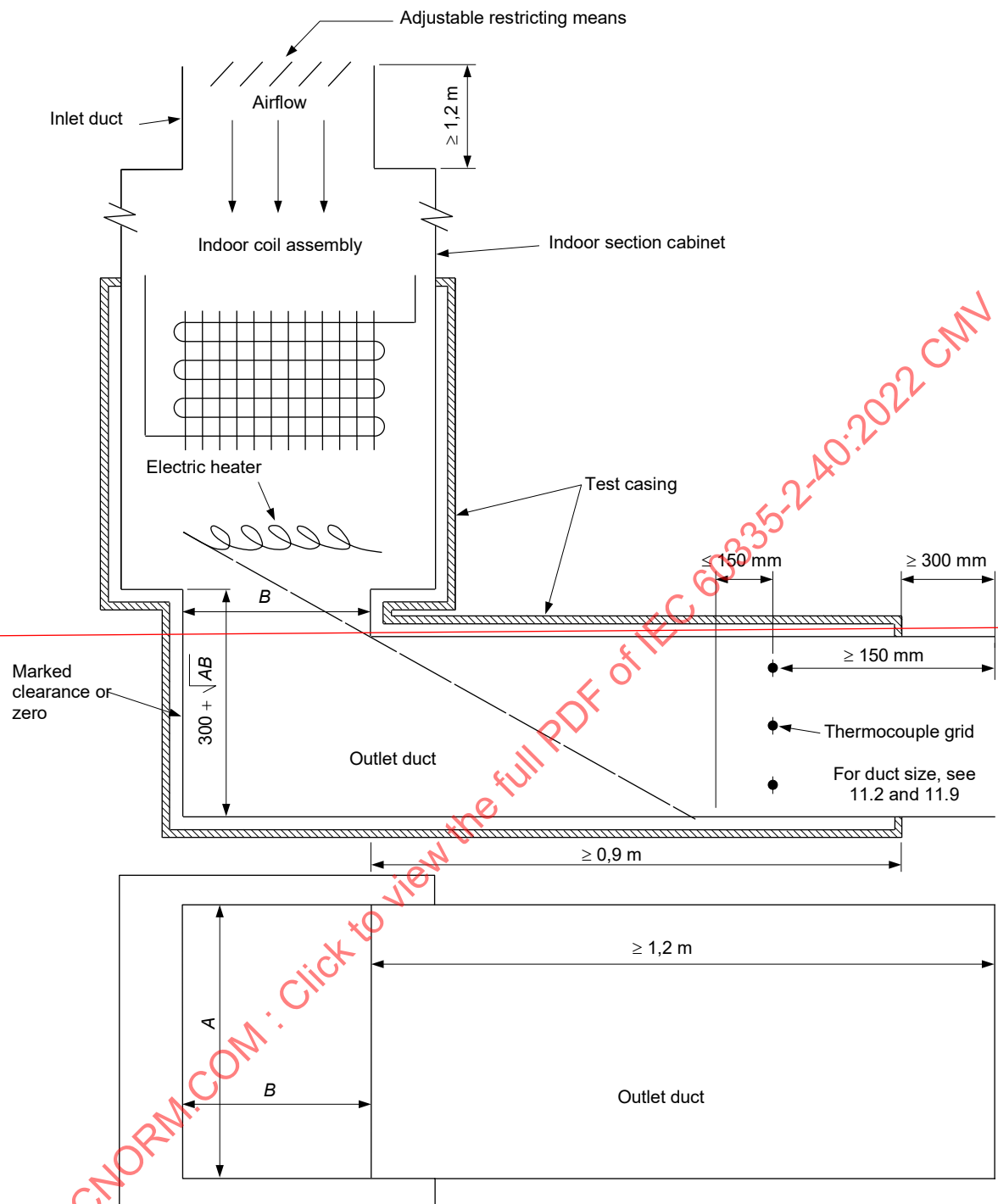
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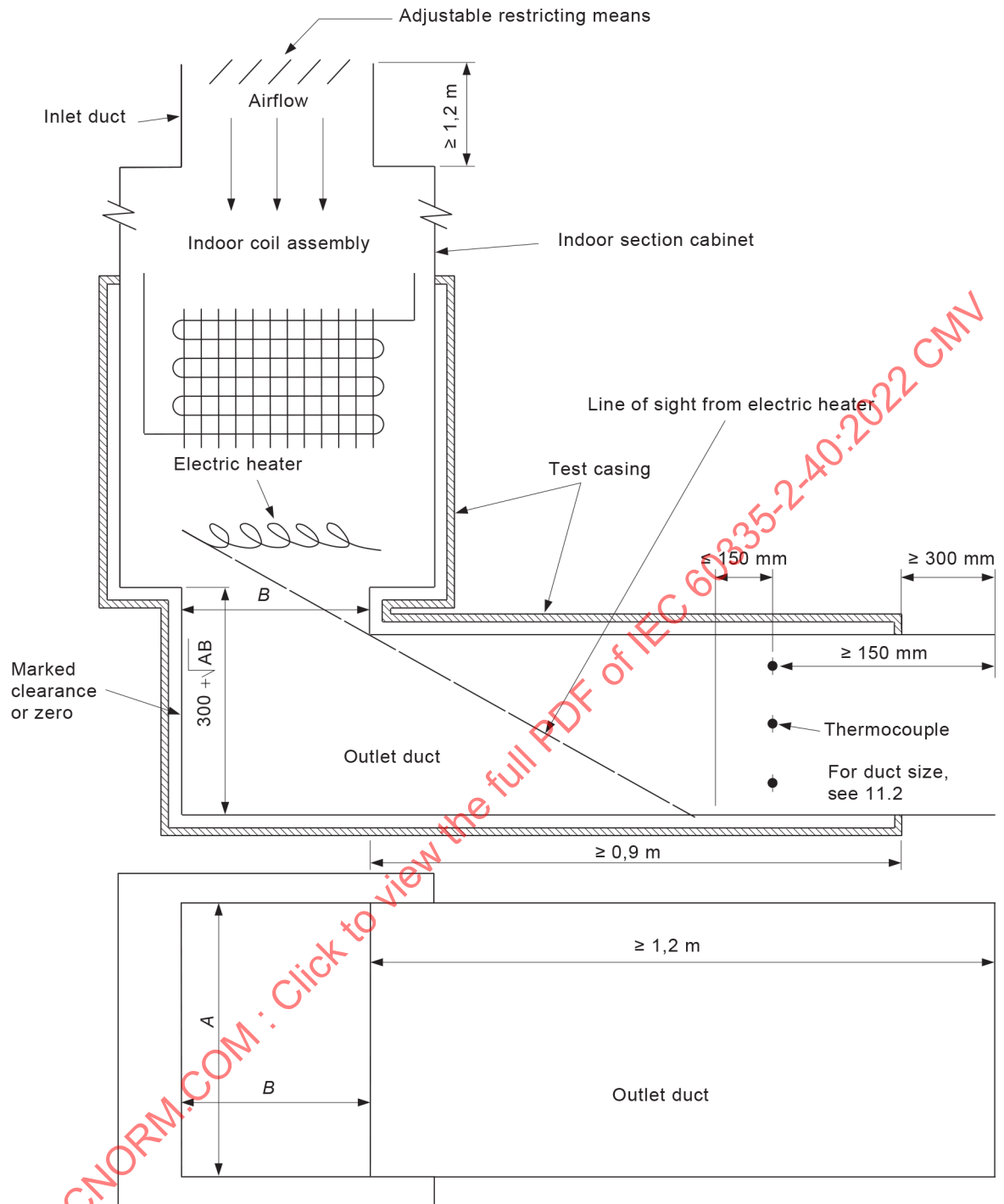




IEC

a) Upflow application

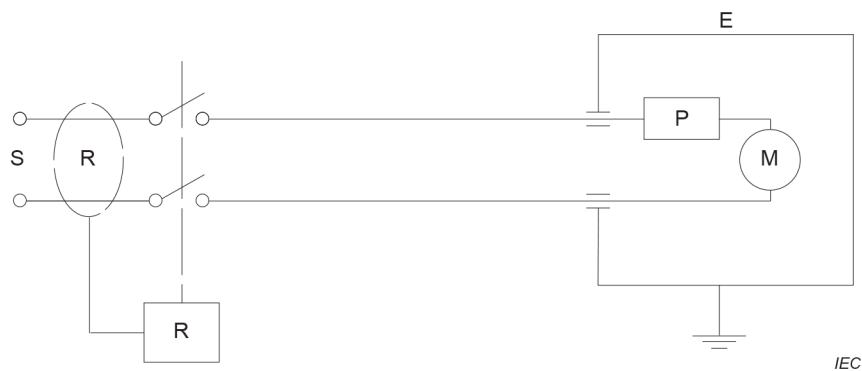




IEC

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

~~Care has to be taken to complete the earthing system to permit the correct operation of the RCCB/RCBO.~~

Figure 103 – Supply circuit for locked-rotor test of a motor of the single-phase type – Revise as needed for three-phase test



Figure 104 – Power spectral density profile for vibration test in 21.101

Dimensions in millimetres

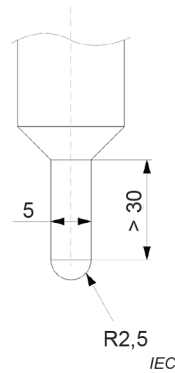
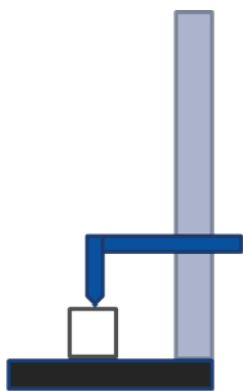
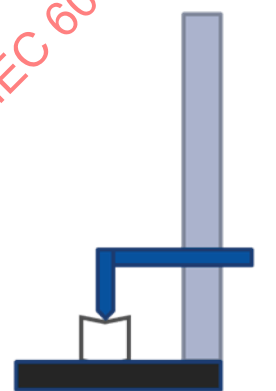


Figure 105 – Dimensional details for the weight in the area of the pressure ball



Measurement 1: Height specimen unloaded



Measurement 2: Height specimen after loading

Figure 106 – Measurement before and after the test

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.

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Annex AA

(informative)

Examples for operating temperatures of the appliance

Table AA.1 gives 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 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. **75**

Table BB.1 – Selected information about refrigerants

NOTE This annex 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 °C	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
R32	Difluoromethane	CH ₂ F ₂	A2L	648	> 800	700	2,13	52,0	NA	0,307	NA	6,7	6,7
R50	Methane	CH ₄	A3	645	NA	~~545~~ 645	0,65	16,0	NA	0,032	NA		
R143a	1,1,1-Trifluoroethane	CF ₃ CH ₃	A2L	750	ND	~~650~~ 750	3,43	84,0	NA	0,282	NA		
R152a	1,1-Difluoroethane	CHF ₂ CH ₃	A2	455	NA	~~355~~ 455	2,70	66,0	NA	0,130	NA		
R170	Ethane	CH ₃ CH ₃	A3	515	NA	~~415~~ 515	1,23	30,1	NA	0,038	NA		
R290	Propane	CH ₃ CH ₂ CH ₃	A3	470	NA	~~370~~ 470	1,80	44,1	NA	0,038	NA		
R600	n-Butane	CH ₃ CH ₂ CH ₂ CH ₃	A3	365	NA	~~265~~ 365	2,37	58,1	NA	0,038	NA		
R600a	Isobutane	CH(CH ₃) ₂ CH ₃	A3	460	NA	~~360~~ 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, $S_{u,i}$ at 23 °C relative humidity at nominal composition	Burning velocity, $S_{u,i}$ 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	~~355~~ 455	1,72	~~42,1~~	NA	0,046	NA		
~~E170~~ RE 170	Dimethylether	(CH ₃) ₂ O	A3	235	NA	~~435~~ 235	1,88	46,1	NA	0,064	NA		
R142b	1-chloro-1,1-difluoroethane	CH ₃ CClF ₂	A2L	750 ^e	ND	~~650~~ 750	4,41	100,5	NA	0,329	NA		
R1234yf	2,3,3-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-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	~~0,323~~ 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	~~0,277~~ 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	~~0,330~~ 0,331		

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, $S_{u,r}$ 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
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	~~4,64~~ 4,71	112,7	112,7	0,322	~~0,346~~ 0,341		
R-451B	R-1234yf/134a	(88,8/11,2)	A2L	ND	> 800	700	~~4,69~~ 4,70	112,6	112,6	0,322	0,341		
R-452B	R-32/125/1234yf	(67,0/7,0/26,0)	A2L	~~ND~~ 509	> 800	700	~~2,60~~ 2,63	63,5	~~63,7~~ 63,5	0,309	0,310	< 4,0	
R-454A	R-32/1234yf	(35,0/65,0)	A2L	~~ND~~ 457	> 800	700	~~3,29~~ 3,34	80,5	81,8	0,273	~~0,278~~ 0,281	< 4,0	
R-454B	R-32/1234yf	(68,9/31,1)	A2L	~~ND~~ 496	> 800	700	~~2,56~~ 2,59	62,6	63,0	0,307	~~0,304~~ 0,296	5,7	
R-454C	R-32/1234yf	(21,5/78,5)	A2L	~~ND~~ 444	> 800	700	~~3,74~~ 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	< 1,5	
R-457A	R-32/1234yf/152a	(18,0/70,0/12,0)	A2L	ND	ND	ND	~~3,58~~ 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	(9,0/42,0/29,0/4,0/8,0)	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 n	Lower flammability limit b,d at worst case formulation on	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
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 <http://standards.iso.org/iso/817/ed-3/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 **A1T-reduced-by-100-K**.
For **A2L refrigerants**, the maximum allowable surface temperature is determined by the highest of **A1T-reduced-by-100-K** or, if tested per Annex KK, the **hot surface ignition temperature** reduced by 100 K, ~~but not higher than 700 °C~~ **76**

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 ~~may~~ 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 need to 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 ~~operation, service and~~ installation, ~~service, maintenance and repair, and decommissioning~~ manuals of appliances using flammable refrigerants

DD.1 General

Each ~~service~~ manual shall include requirements of clauses according to Table DD.1. Different manuals can be combined into one manual.

Numerical values needed 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. **77**

For **factory sealed single package units**, the installation manual does not need to include material from DD.4.8 and Clause DD.9.

Table DD.1 – Mandatory clauses in each manual **78**

Clause	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 manual 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.5.1	No	Yes	No	
DD.5.2	No	Yes	No	
DD.6	~~No~~ Yes	Yes	No	
DD.7	Yes	Yes	~~No~~ Yes	
DD.8	~~Yes~~ No	Yes	Yes	
DD.9	Yes	Yes	~~Yes~~ No	
DD.10	~~Yes~~ No	~~Yes~~ No	~~No~~ Yes	
DD.11	No	No	Yes	
DD.12	No	~~No~~ Yes	Yes	
~~DD.13~~	~~Yes~~	~~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 ~~may~~ 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 manual

DD.3.1 General

The following information shall be specified in the manual where the information is needed for the function of the manual and as applicable to the appliance: **79**

- ~~— information for spaces where refrigerant pipes are allowed, including statements~~
 - ~~• that the installation of pipe work shall be kept to a minimum;~~
 - ~~• that pipe work shall be protected from physical damage and, in the case of flammable refrigerants, shall not be installed in an unventilated space, if that space is smaller than A_{min} in Annex GG, except for A2L refrigerants where the installed pipes comply with 22.116. In case of field charge, the effect on refrigerant charge caused by the different pipe length has to be quantified;~~
 - ~~• that compliance with national gas regulations shall be observed;~~
 - ~~• that mechanical connections made in accordance with 22.118 shall be accessible for maintenance purposes;~~
 - ~~• that, for appliances containing flammable refrigerants, the minimum floor area of the room shall be mentioned in the form of a table or a single figure without reference to a formula;~~
- ~~— the maximum refrigerant charge (m_{max});~~
- ~~— instructions 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;~~
- ~~— the minimum rated airflow, if required by Annex GG;~~
- ~~— information for handling, installation, cleaning, servicing and disposal of refrigerant;~~
- ~~— for appliances using flammable refrigerants, instructions shall include the minimum installed height h_{inst} (when required to calculate A_{min}), refrigerant charge m_e and minimum room area of the space A_{min} or a minimum room area of conditioned space TA_{min} .~~

where applicable. Additional minimum room area data may be provided based on other **installed heights** and/or charge levels.

- detailed instructions on how to install the appliance to ensure that the release height h_0 as determined in Clause GG.2 of the installed appliance is not lower than h_0 used for the calculation of $A_{\min}$;
- a warning to keep any required ventilation openings clear of obstruction;
- a notice that servicing shall be performed only as recommended by the manufacturer;
- a warning that ducts connected to an appliance shall not contain a **potential ignition source**;
- 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;
- for appliances relying on safety measures according to GG.8.3 instructions for wiring to external ventilation;
- when a remote located refrigerant sensor is specified by the manufacturer, the instructions shall state when it is required and how to install and connect the sensor;
- 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;
- the following information requirements apply for **enhanced tightness refrigerating systems** using **A2L refrigerants**:
 - Equipment piping in the occupied space shall be installed in such a way to protect against accidental damage in operation and service.
 - Precautions shall be taken to avoid excessive vibration or pulsation to refrigerating piping.
 - 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.
 - Provision shall be made for expansion and contraction of long runs of piping.
 - Piping in **refrigerating systems** shall be so designed and installed to minimize the likelihood hydraulic shock damaging the system.
 - Solenoid valves shall be correctly positioned in the piping to avoid hydraulic shock.
 - Solenoid valves shall not block in liquid refrigerant unless adequate relief is provided to the refrigerant system low pressure side.
 - Steel pipes and components shall be protected against corrosion with a rustproof coating before applying any insulation.
 - Flexible pipe elements shall be protected against mechanical damage, excessive stress by torsion, or other forces. They should be checked for mechanical damage annually.
 - The indoor equipment and pipes shall be securely mounted and guarded such that accidental rupture of equipment cannot occur from such events as moving furniture or reconstruction activities.
 - Where safety shut off valves are specified, the minimum room area may be determined based on the maximum amount of refrigerant that can be leaked as determined in GG.12.2.
 - Where safety shut off valves are specified, the location of the valve in the **refrigerating system** relative to the occupied spaces shall be as described in GG.12.1.
 - 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.

~~For mechanical ventilation as specified in GG.8.3, the air extraction opening from the room shall be located equal or below the refrigerant release point. For floor mounted units, it shall be as low as practicable. The air extraction openings shall be located in a sufficient distance from the air intake openings to prevent re-circulation to the space.~~

- 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;

NOTE Additional requirements for field-testing are in DD.3.1, item 26).

- d) that compliance with national gas regulations shall be observed;
- 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_{rl} . **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** 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** GG.11.3.3;
- 12) for appliances relying on safety measures according to GG.8.3 or for **enhanced tightness refrigerating systems** 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 may 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 manual shall include a statement advising that an unventilated area where the appliance ~~using flammable refrigerants~~ 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 ~~non-fixed~~ 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 ~~non-fixed~~ 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 ~~with A2L refrigerants~~ 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 ~~using A2L refrigerants~~ connected via an air duct system to one or more rooms, a warning with the substance of the following: "Auxiliary devices which ~~may~~ **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 ~~using A2L refrigerants~~ 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 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, ~~if those devices have a potential to become an ignition source.~~

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 manual 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 ~~according to Annex HH.~~

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 manual 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 ~~may~~ 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 ~~actual~~ **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 ~~may~~ **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 to 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 ~~Repairs to~~ Sealed ~~electrical~~ components

~~DD.5.1 During repairs to sealed components, all electrical supplies shall be disconnected from the equipment being worked upon prior to any removal of sealed covers, etc. If it is absolutely necessary to have an electrical supply to equipment during servicing, then a permanently operating form of leak detection shall be located at the most critical point to warn of a potentially hazardous situation.~~

~~DD.5.2 Particular attention shall be paid to the following to ensure that by working on electrical components, the casing is not altered in such a way that the level of protection is affected. This shall include damage to cables, excessive number of connections, terminals not made to original specification, damage to seals, incorrect fitting of glands, etc.~~

~~Ensure that the apparatus is mounted securely.~~

~~Ensure that seals or sealing materials have not degraded to the point that they no longer serve the purpose of preventing the ingress of flammable atmospheres. Replacement parts shall be in accordance with the manufacturer's specifications.~~

Sealed electrical components shall not be repaired. **80**

~~DD.6 Repair to intrinsically safe components~~

~~Do not apply any permanent inductive or capacitance loads to the circuit without ensuring that this will not exceed the permissible voltage and current permitted for the equipment in use.~~

~~Intrinsically safe components are the only types that can be worked on while live in the presence of a flammable atmosphere. The test apparatus shall be at the correct rating.~~

~~Replace components only with parts specified by the manufacturer. Other parts may result in the ignition of refrigerant in the atmosphere from a leak.~~ **80**

~~NOTE The use of silicon sealant can inhibit the effectiveness of some types of leak detection equipment. Intrinsically safe components do not have to be isolated prior to working on them.~~

DD.76 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 aging or continual vibration from sources such as compressors or fans.

DD.87 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 ~~may not~~ can be ~~adequate~~ inadequate, or ~~may~~ can need 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 ~~may~~ can react with the refrigerant and corrode the copper pipe-work.

NOTE Examples of leak detection ~~fluids~~ methods are

- bubble method,
- fluorescent ~~agent~~ method ~~agents~~.

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.98.

DD.98 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 following local and national regulations;
- evacuate;
- purge the circuit with inert gas (optional for A2L);
- evacuate (optional for A2L);

~~— purge with inert gas (optional for A2L);~~

- continuously flush with inert gas when using flame to open circuit;
- open the circuit ~~by cutting or brazing.~~

The **refrigerant charge** shall be recovered into the correct recovery cylinders. ~~For appliances containing flammable refrigerants other than A2L refrigerants, the system shall be purged with oxygen-free nitrogen to render the appliance safe for flammable refrigerants. This process may need to be repeated several times. Compressed air or oxygen shall not be used for purging refrigerant systems.~~

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.

~~For appliances containing flammable refrigerants, other than A2L refrigerants, refrigerants~~
Purging of the refrigerant circuit shall be achieved by breaking the vacuum in the system with ~~oxygen-free nitrogen~~ inert gas and continuing to fill until the working pressure is achieved, then venting to atmosphere, and finally pulling down to a vacuum. This process shall be repeated until no refrigerant is within the system. ~~When the final oxygen-free nitrogen charge is used, The system shall be vented down to atmospheric pressure to enable work to take place. This operation is absolutely vital if brazing operations on the pipe work are to take place.~~ **81**

Ensure that the outlet ~~for~~ of the vacuum pump is not close to any potential ignition sources and that ventilation is available.

DD.109 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.110 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 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 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 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) Recovered refrigerant shall not be charged into another **refrigerating system** unless it has been cleaned and checked.

DD.12.11 Labelling

Equipment shall be labelled stating that it has been de-commissioned 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.13.12 Recovery

When removing refrigerant from a system, either for servicing or decommissioning, it is ~~recommended~~ 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 ~~all appropriate refrigerants including, when applicable, 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. ~~Before using the recovery machine, check that it is in satisfactory working order, has been properly maintained and that any associated electrical components are sealed to prevent ignition in the event of a refrigerant release. Consult manufacturer if in doubt.~~

The recovered refrigerant shall be ~~returned~~ processed according to ~~the refrigerant supplier~~ local legislation in the correct recovery cylinder, and the relevant waste transfer note arranged. 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 evacuation process shall be carried out prior to returning the compressor to the suppliers. Only electric heating to the compressor body shall be employed to accelerate this~~

~~process.~~ The compressor body shall not be heated by an open flame or other ignition sources to accelerate this process. ~~82-When oil is drained~~ Draining of oil from a system, ~~it~~ shall be carried out safely.

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Annex EE (normative)

Pressure tests

EE.1 General

All **refrigerating system** parts shall withstand the maximum ~~allowable~~ pressure ~~expected~~ in **normal operation**, abnormal operation, and standstill. **83**

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.

A compressor tested ~~for compliance~~ and found to comply with IEC 60335-2-34 need not be additionally tested.

Compliance is checked by the ~~following~~ tests in Clause EE.3 or EE.4.

~~For all tests of Clause 21, if the refrigerant is a blend, the test pressure of EE.4.2 shall be carried out at the highest pressure under the specified temperature.~~

~~The test value that is the maximum of Clauses EE.2, EE.3 or EE.4 shall be used for the test of EE.4.2, respectively, for the high side and the low side components.~~

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.

Pressure gauges and control mechanisms need not be subjected to the test, provided the parts meet the requirements of the component.

~~EE.2 Pressure test value determined under testing carried out in Clause 11~~

~~A **refrigerating system** component that is exposed to pressure shall be subjected to measurement of the **maximum allowable pressure** developed in the **refrigerating system** when tested under the conditions specified in Clause 11.~~

~~The pressure test value shall be at least three times the **maximum allowable pressure** developed during operation under Clause 11.~~

~~EE.3 Pressure test value determined under testing carried out in Clause 19~~

~~A **refrigerating system** component that is exposed to pressure shall be subjected to measurement of the **maximum allowable pressure** developed in the **refrigerating system** when tested under the conditions specified in Clause 19.~~

~~The pressure test value shall be at least three times the **maximum allowable pressure** developed during abnormal operation (see Clause 19).~~

EE.42 ~~Pressure test value determined under testing carried out under standstill conditions~~ **Determination of standstill pressure**

EE.4.1 ~~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 ~~shall~~ can be subjected to measurement of the ~~maximum allowable pressure developed in the refrigerating system~~ exposed to a higher pressure under the condition of standstill than under **normal operation**.

~~The pressure test value shall be at least three times the maximum allowable pressure developed during standstill.~~

~~Pressure gauges and control mechanisms need not be subjected to the test, provided the parts meet the requirements of the component.~~

EE.4.23 **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, ~~during which time the sample 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.~~

EE.54 **Fatigue test** ~~option for Clause EE.1 and EE.4.2~~

EE.5.1 ~~The components shall be subjected to a test at 66,7 % of 2 times the test marked **maximum allowable pressure** determined by Clauses EE.2, EE.3 or EE.4, provided the components comply with the fatigue test in Clause EE.5. This test is conducted on a separate sample.~~

EE.5.2 ~~Three samples of each refrigerant-containing part shall be tested at the cyclic pressure values specified in EE.5.7 and EE.5.8 for the number of cycles specified in EE.5.6, as described in EE.5.4.~~

EE.5.3 ~~The samples shall be considered to comply with EE.5.5 on completion of the test and if they do not rupture, burst, or leak.~~

Three samples of each refrigerant-containing part shall be tested. The total number of cycles shall be 250 000.

EE.5.4 *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, ~~it is suggested that~~ a non-compressible fluid ~~is~~ 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 °C greater than the temperature of the part measured during the test of Clause 11 for copper or aluminium and 60 °C 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.

~~EE.5.5 The pressure for the first cycle shall be the maximum evaporating pressure for low-pressure side components or the maximum condensing pressure for the high-pressure side components.~~

~~EE.5.6 The total number of cycles shall be 250 000. The test pressures shall be determined by EE.5.7 (except the first and last cycles as noted in EE.5.5 and EE.5.8).~~

*The pressure for the first cycle shall be the marked **maximum allowable pressure**.*

~~EE.5.7~~ 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 be not 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.

~~EE.5.8 For the final test cycle, the test pressure shall be increased to two times the minimum upper pressure specified in EE.5.7.~~

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 ~~at the most critical point~~ in the **refrigerating system** at the **potential leak points**. The method to simulate a leakage at the ~~most critical point~~ **potential leak points** is to inject refrigerant vapour through a suitable capillary tube at that point. ~~A critical point is a joint in the refrigerant system tubing, a bend of more than 90°, or other point judged to be a weak point in the refrigerant containing system due to the thickness of the metal, exposure to damage, sharpness of a bend or the manufacturing process. A quantity of refrigerant leaked is equal to the rated refrigerant charge or the amount that will leak as determined by test. The refrigerant is injected at the most critical point and the most unfavourable direction at ambient temperature (20 °C to 25 °C). Where LFL is referenced in this annex, the LFL shall be taken at the nominal composition as specified in ISO 817 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. **84**

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 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 hour with the leak rate $\dot{m}_{leak}$ of GG.14.3.

The leak rate shall be maintained at 25 % ± 5 % of the ~~refrigerant charge in 1 min~~ 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. **85**

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**, ~~whichever gives the most unfavourable result unless a prepurge is activated prior to energizing any loads, in which case the test shall be conducted with the appliance~~

~~operating~~. 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. **86**

FF.2.3 For refrigerant blends, the test shall be carried out using the nominal composition as defined in ~~ISO 817~~ 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 ~~has to~~ shall be taken to avoid any condensation occurring in the vessel.

FF.2.4 The test is conducted in a room that is ~~draft~~ draught-free and of sufficient size to conduct the test.

The minimum volume (V) is:

$$V = (15 \times m_e) / LFL \quad V = (15 \times m_{FF}) / LFL \quad (\text{FF.1})$$

where

V is the minimum volume in m³ with a ceiling height not less than 2,2 m;

~~m_e is the refrigerant charge in kg;~~

m_{FF} is the quantity of refrigerant leaked as defined in FF.2.1 in kg;

LFL is the **lower flammability limit** in kg/m³.

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 ~~fast response to the gas concentration, typically 2 s to 3 s~~ t(90) response time of faster than 30 seconds 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 ~~the~~ 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 ~~or the duration of the test if less than 5 min~~ during and after the amount has been injected. ~~The measured concentration of refrigerant gas surrounding a component that will not function during the prepurge time may exceed the 25 % of the LFL during the prepurge time. The LFL is as specified in Annex BB for the refrigerant used.~~

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 installation space of 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.

~~Symbol m_c denotes the refrigerant charge of a single refrigerating system. Where multiple refrigerating systems are servicing the same space, the refrigerating system with the largest refrigerant charge shall be used.~~

For appliances with multiple **refrigerating systems**, each **refrigerating system** shall be evaluated independently. **87**

Where multiple values of A_{min} are found based on different **operating states**, the highest value shall be A_{min} for the appliance. **88**

NOTE 1 This can be the case when different measures are used under different **operating states**. 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 WCF – Worst Case Formulation as ~~defined in ISO 817~~ specified in Annex BB.

Toxicity charge limits shall be determined per 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. **89**

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 clauses: GG.2, GG.3, GG.4, GG.7, GG.9, and GG.14. The **refrigerant charge** m_c may be replaced by the **releasable charge** m_{rl} in the formulae of Annex GG. **90**

NOTE 42 Table GG.1 is provided as guidance when applying Annex GG. Determine the column for indoor or outdoor application. The requirements are identified in the appropriate box where the product and installation requirements are identified.

NOTE 2 The factors in the formulas are in cubic metres and are the incremental room sizes that relate to increasing refrigerant charge and the type of ventilation permitted or required for the room that avoid reaching the lower flammability limit, if the entire refrigerant charge is released and mixed with the room air. The formulas governing the refrigerant charge are based on a consideration of non uniform mixing, if the refrigerant is heavier or lighter than air.

NOTE 3 For the LFL of a refrigerant not included in Annex BB, it is referred to ISO 817. If the LFL is also not listed in ISO 817, the method to determine the LFL of a blend refrigerant is defined in ISO 817.

NOTE 53 The requirements applicable to a higher refrigerant charge are permitted for each range in Table GG.1.

Table GG.1 – Outline of Annex GG (informative)

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 $m_{r1} \leq m_1$	No room size restriction			No room size restriction, GG.6
$m_1 < m_c \leq 2 \times m_1$ (~~non-fixed-appliance~~ appliances which are not fixed appliances)	Not allowed	GG.7	Not allowed	
$m_1 < m_c \leq m_2$	GG.2.1	GG.2.2 ^c , GG.2.3 ^d , GG.9 ^c , GG.10 ^{c,d} , GG.14 ^d	GG.3, GG.8 ^c , GG.10 ^{c,d}	
$m_2 < m_c \leq m_3$	Not allowed	GG.9 ^c , GG.10 ^{c,d}	GG.3, GG.8 ^c , GG.10 ^{c,d}	
$m_c > m_3$	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 Refrigerant charge is limited to $m_1 < m_c \leq 4 \times m_2$.~~

^d These clauses are only applicable to appliances with A2 or A3 refrigerant.

GG.1.2 Determination of the case-applicable refrigerant capped quantity limit

Determine the case-applicable based on the relationship of the refrigerant charge (m_c) and m_1 , m_2 , m_3 , defined as follows:

For A2 and A3 refrigerants, m_1 , m_2 , m_3 are defined as follows:

$$m_1 = 4 \times LFL \quad (GG.1)$$

$$m_2 = 26 \times LFL \quad (GG.2)$$

$$m_3 = 130 \times LFL \quad (\text{GG.3})$$

where LFL is the **lower flammability limit** in kg/m^3 for the refrigerant used.

For **A2L refrigerants**, m_1 , m_2 , m_3 are defined as follows:

$$m_1 = 6 \times LFL \quad (\text{GG.4})$$

$$m_2 = 52 \times LFL \quad (\text{GG.5})$$

$$m_3 = 260 \times LFL \quad (\text{GG.6})$$

where LFL is the **lower flammable limit** in kg/m^3 for the refrigerant used.

~~If an appliance with A2L refrigerant has more than one refrigerating system, refrigerant charge (m_e) refers to the refrigerating system with the largest charge serving the same space.~~

NOTE The factors in the formulae are in m^3 .

GG.1.3 Determination of unventilated room area ~~for appliances using A2L refrigerants~~

GG.1.3.1 General

For the purpose of determination of room area (A) when used to calculate the **maximum allowable 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, ~~$A_{\text{nv,min}}$~~ $A_{\text{nv,min}}$, shall not be less than the following:

$$A_{nv,min} = \frac{m_c - m_{max}}{LFL \times 104} \times \sqrt{\frac{A}{g \times m_{max}} \times \frac{M}{M - 29}} \quad (GG.7)$$

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 ~~Clause GG.2~~ 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/s²;
- 29 is the average molar mass of air in kg/kmol;
- 104 is a constant.

~~The equation is not applicable for refrigerants with a molar mass less than 42, as the equation is based on the principle that the density of the gases generates sufficient driving force to be successfully used with natural ventilation.~~

GG.1.3.3 Determination of unventilated room area for appliances using A2 and A3 refrigerant **91**

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 of the openings between the wall and floor which connect the rooms 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** $m_1 < m_c \leq m_2$ and for **non-fixed 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 **non-fixed 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:

$$m_{\max} = 2,5 \times (LFL)^{(5/4)} \times h_0 \times (A)^{1/2}, \text{ not to exceed } m_{\max} = SFCF \times LFL \times h_0 \times A \text{ (GG.8)}$$

or the required minimum **floor room area** $A_{\min}$ to install an appliance with **refrigerant charge** m_c (kg) shall be in accordance with following:

$$A_{\min} = (m_c / (2,5 \times (LFL)^{(5/4)} \times h_0))^2, \text{ not less than } A_{\min} = m_c / (SFCF \times LFL \times h_0) \text{ (GG.9)}$$

where

$m_{\max}$ is the allowable **maximum refrigerant charge** in a room, in kg;

m_c is the **refrigerant charge** in 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;

~~SF is a safety factor with a value of 0,75;~~

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; **92**

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.53). 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.5~~ 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** ~~have to~~ 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 ~~may~~ 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 ~~more~~ not less than **respective** $A_{\min}$, no further measure is required. If any room area of spaces is below $A_{\min}$, measures according to Clause GG.8 or GG.9 shall be provided for appliances using **A2L refrigerants**.

~~NOTE This formula is not applicable for refrigerants lighter than 42 kg/kmol.~~

GG.2.2 Fixed appliances using A2L refrigerants with ~~incorporated~~ integral circulation airflow

GG.2.2.1 General

~~Incorporated circulation airflow applies to fixed appliances only.~~

When the fan ~~incorporated~~ **integrated** into an appliance is continuously operated or operation is initiated by a ~~refrigerant leak detection system~~ **refrigerant leak detection system** with a sufficient **circulation airflow** ~~rate~~ (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:

$$m_{\max} = 0,75 \times LFL \times h_{ra} \times A$$

$$m_{\max} = CF \times LFL \times h_{ra} \times A \quad (\text{GG.10})$$

or the required minimum room area $A_{\min}$ of installed appliance with **refrigerant charge** m_c (kg) shall be in accordance with following:

$$A_{\min} = m_c / (0,75 \times LFL \times h_{ra})$$

$$A_{\min} = m_c / (CF \times LFL \times h_{ra}) \quad (\text{GG.11})$$

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 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 ~~rate~~ 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 ~~air delivery height in upper side~~ 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.64 for examples.				

$$h_d = \left(1 + \frac{2,35}{LFL \left(1 - \frac{1,2}{\rho} \right) + 0,05} \right) \times (0,0183 \times v^2 \times \sin^2 \varphi) \quad (GG.12)$$

where

v is the **circulation airflow** velocity in m/s;

φ is the **circulation airflow** elevation angle from horizontal in degrees ($0^\circ \leq \varphi \leq 90^\circ$);

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.6~~ 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. **93**

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 ~~detected continuously or~~ monitored continuously. Within 10 seconds 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 ~~refrigerant~~ leak detection system

If a ~~refrigerant~~ leak detection system is activated ~~per Annex LL~~, the following actions shall be taken and continued for at least 5 min after the ~~refrigerant~~ leak detection system has reset:

~~— The fan shall be switched on.~~

- 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.

~~Where a remote refrigerant detection system is used in a room with multiple units, all of the detection system activated safety measures shall be applied to all units in the room which rely on the remote refrigerant detection system.~~

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 m³/h;
- 3 600 is a constant to convert m³/s to m³/h;
- 8 is a constant;
- 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;
- 240 is a constant based on leaking the total **refrigerant charge** in 4 minutes;
- m_c is the actual **refrigerant charge** amount in the system in kg;
- LFL is the **lower flammability limit** in kg/m³;
- 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 $A_{\min}$. 94

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 seconds 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 shaft duct. The manufacturer shall specify the exhaust ventilation shaft width and height 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 shall be at least $Q_{\min}$:

$$Q_{\min} = S \times 15 (24,5 \times m_c / M) \text{ (with a minimum of } 2 \text{ m}^3/\text{h}) \quad (\text{GG.13})$$

where

S is a safety factor of 4;

M is the molar mass of refrigerant in g/mol;

$Q_{\min}$ is the minimum required volume flow of the ventilation in m^3/h ;

m_c is the refrigerant charge;

24,5 is the gas constant in l/mol;

15 is the conversion from per minute to per hour with 4 min scenario.

NOTE 1 The constant 15 above is based on the assumptions used for the charge size formulas, i.e. releasing the full refrigerant charge within 4 min.

NOTE 2 For blends, the molar mass is the mole fraction weighted average of the molar masses of the components.

$$Q_{\min} = 3\,600 \times 1 / CF \times 24,5 / M \times \dot{m}_{\text{leak}} \text{ (with a minimum of } 2 \text{ m}^3/\text{h}) \quad (\text{GG.16})$$

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 ;

m_c is the refrigerant charge in kg;

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. **95**

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 seconds 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.

~~Ventilation shall be to the outside or to a room with a minimum volume as specified under the unventilated area case.~~

~~The airflow is detected continuously or monitored continuously and the appliance or the motor compressor is switched off within 10 s in the event that the airflow is reduced below Q_{min} .~~

~~or~~

~~The ventilation is switched on by a refrigerant detection system before 25 % of the **LFL (lower flammability limit)** is obtained. The sensor shall be suitably located considering the density of the refrigerant and periodically proved in accordance to the instructions. The airflow is periodically checked and detected and the appliance or the motor compressor is switched off within 10 s in the event that the airflow is reduced below Q_{min} .~~

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. **96**

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 ~~if these areas are covered by Annex GG. The following may be considered to comply with this requirement.~~ 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 ~~may~~ 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 manual the water quality necessary for the specified **heat exchanger**;
 - brine: the manufacturer shall specify in the installation manual the type of brine and its permitted concentration range for which the **heat exchanger** is suitable.
 - 2) the use of a freezing protection device ~~(testing of which is described in item 2) below)~~ 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** ~~may~~ can be damaged as a result of freezing (i.e. 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). ~~Allowance for the Measurement tolerance has to~~ 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 ~~Non-fixed~~ 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 ~~non-fixed~~ 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:

$$m_{\max} = 0,25 \times A \times LFL \times 2,2$$

$$m_{\max} = CF \times A \times LFL \times 2,2 \quad (\text{GG.14}18)$$

or the required minimum floor room area, $A_{\min}$, to install an appliance with refrigerant charge m_c shall be in accordance with the following:

$$A_{\min} = m_c / (0,25 \times LFL \times 2,2)$$

$$A_{\min} = m_c / (CF \times LFL \times 2,2) \quad (\text{GG.15}19)$$

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 , as referred in Annex BB;
- 2,2 is the minimum ceiling height employed in metres (m).

~~0,25 — is a safety factor.~~

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.7.2.54. 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 Random vibration test**~~

~~The appliance is tested in its final packaging for transport and shall withstand a random vibration test for 180 min according to ASTM D 4728-06. The power spectral density profiles to be applied are those specified in Figure X1.1 and Table X1.1 of ASTM D 4728-06:2012 for truck transportation.~~

~~**GG.7.2.32 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 the following 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.7.2.43 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 the following 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.7.2.54 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

~~The appliance shall be constructed so that its operation does not cause resonance points in the piping connected to the compressor.~~

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**. 97

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 per manufacturer's instruction. Testing shall be conducted in fan only mode, and the heating and cooling mode if applicable.

~~The supply frequency is increased in steps of 1 Hz between 0,9 times and 1,1 times the rated frequency.~~

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 amplitude is measured at critical points in the piping. There shall be no sudden increase of the amplitude when increasing the supply frequency within the specified range.~~

~~NOTE 1 The vibration amplitude can be measured, for example, by sliding an arrow gauge along the piping. The arrow gauge is an isosceles triangle with a height equal to 10 times the base (see Figure GG.3) and is held against the piping with the arrow axis perpendicular to the direction of the vibration to be measured. The amplitude is the value of A (see Figure GG.4) divided by 10.~~

~~NOTE 2~~ 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** $0 < m_e \leq m_3$ $m_1 < m_c \leq m_3$.

Ventilation according to GG.8.2 or GG.8.3 shall be ~~employed~~ provided when **refrigerant charge** is $m_c > m_{\max}$.

Natural and mechanical ventilation apply to **fixed appliances** only.

~~GG.8.2 Natural ventilation requirements for appliances using A2L refrigerants~~

~~GG.8.2.1 General~~

~~Natural ventilation shall be permitted for A2L refrigerants on the conditions as outlined in GG.8.2.2 and GG.8.2.3.~~

~~Subclause GG.8.2 is applicable for appliances with a refrigerant charge of $m_e < m_3$.~~

~~GG.8.2.2 Natural ventilation to occupied indoor space~~

~~If natural ventilation is applied in occupied space, all of the following shall be met.~~

- ~~— Natural ventilation shall be made to a room where sufficient air is available to dilute the refrigerant below the LFL.~~
- ~~— Natural ventilation from an occupied space shall not be made to outdoor.~~

~~NOTE User can block the natural ventilation to the outside if it is cold outside.~~

- ~~— For natural ventilation opening provided to an unoccupied space, the total area of the space in which the appliance is installed and the adjacent space which is connected by the natural ventilation shall have a room area more than $A_{\min}$ according to Clause GG.2 for m_e . If the total room area is not large enough, the measure of GG.8.3 or Clause GG.9 shall be taken.~~
- ~~— The openings for natural ventilation shall comply with GG.1.4.~~

~~The minimum opening area for natural ventilation shall be calculated using the following equation:~~

$$Anv_{\min} = \frac{m_c - m_{\max}}{LFL \times 104} \times \sqrt{\frac{A}{g \times m_{\max}} \times \frac{M}{M - 29}} \quad (GG.16)$$

where

~~Anv_{min}~~ is the minimum opening area for natural ventilation in m²;

~~m_c~~ is the actual **refrigerant charge** in the system in kg;

~~m_{max}~~ is the allowable **maximum refrigerant charge** for a system in kg calculated in accordance with Clause GG.2 or m₂, whichever is lower;

~~LFL~~ is the **lower flammability limit (LFL)** in kg/m³;

~~A~~ is the room area in m²;

~~M~~ is the molar mass of the refrigerant;

~~g~~ is the gravity acceleration of 9,81 m/s².

~~The equation is not applicable for refrigerants with a molar mass less than 42, as the equation is based on the principle that the density of the gases generates sufficient driving force to be successfully used with natural ventilation.~~

GG.8.2.3 Natural ventilation to outdoors ~~or unoccupied indoor space~~

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 in occupied space, all of the following shall be met.

- Natural ventilation to ~~the outside~~ outdoors is not allowed below ground level.
- ~~For natural ventilation opening provided to an unoccupied space, the total area of the space in which the appliance is installed and the adjacent space which is connected by the natural ventilation, shall have a room area more than A_{min} according to Clause GG.2 for m_c. If the total room area is not large enough, other measure of GG.8.3 or Clause GG.9 shall be taken.~~
- Natural ventilation from an occupied space shall not be made to outdoors.

NOTE 2 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_{nv,min}, for natural ventilation to outdoors shall be calculated using the following formulae:

$$m_{\max} = \frac{\left(\frac{Anv_{\min}}{0,14} \right)^2}{\frac{0,04}{LFL}} \quad m_{\max} = \frac{\left(\frac{A_{nv}}{0,14} \right)^2}{\left(\frac{0,04}{LFL} \right)} \quad (GG.17, 20)$$

$$Anv_{\min} = 0,14 \times \sqrt{m_c \times \frac{0,04}{LFL}} \quad A_{nv,\min} = 0,14 \times \sqrt{m_c \times \frac{0,04}{LFL}} \quad (GG.18, 21)$$

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/m^3 ;

A_{nv} is the opening area in m^2 ;

$A_{nv,min}$ is the ~~total~~ minimum opening area in m^2 ;

0,14 is a constant derived from the gravity acceleration, flow coefficient, etc.;

0,04 is the conversion constant from hydrocarbon LFL to other LFL . 98

~~The equation is not applicable for refrigerants with a molar mass less than 42, as the equation is based on the principle that the density of the gases generates sufficient driving force to be successfully used with natural ventilation.~~

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

~~Where mechanical ventilation is required, GG.8.3.1.1 or GG.8.3.1.2 shall apply.~~

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 ~~the fan~~ mechanical ventilation system

The ~~fan~~ mechanical ventilation system shall run continuously, other than for short periods for maintenance and service. The airflow shall be ~~detected continuously or~~ monitored continuously. Within 10 seconds 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.8.3.1.23 Fan Mechanical ventilation system activated by a ~~refrigerant~~ leak detection system

~~If a refrigerant detection system is activated per Annex LL, the following actions shall be taken and continue for at least 5 min after the refrigerant detection system has reset:~~

- ~~— The fan shall be switched on.~~
- ~~— Disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.~~

~~The refrigerant detection system and controls shall maintain the purge cycle for at least 5 min after the refrigerant detection system has reset.~~

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.

$$Q = \frac{m_c - m_{\max}}{4 \times LFL} \times 2 \times 60 \quad Q_{\min} = \frac{m_c - m_{\max}}{4 \times LFL} \times 2 \times 60 \quad (\text{GG.19/22})$$

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 ~~Clause GG.2~~ 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 ~~volume~~ area is larger than the minimum area of the room ~~volume~~ which the mechanical ventilation exhausts into, $EA_{\min}$, calculated using the following formula:

$$V = 4 \times m_c / LFL \quad (\text{GG.20})$$

where

- m_c is the **refrigerant charge** in kg;
- LFL is the **lower flammability limit** in kg/m³;
- V is the minimum room volume in m³;
- 4 is the assumed leak time (4 min).

$$EA_{\min} = (m_c - m_{\max}) / (CF \times LFL \times H) \quad (\text{GG.23})$$

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. 99

GG.8.3.3 Requirement for opening

~~The lower edge of the opening of the mechanical ventilation shall not be more than 100 mm above the floor.~~

~~The air extraction openings shall be located at sufficient distance from the air intake openings to prevent re-circulation to the space.~~

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** $0 < m_e \leq m_1$, $m_1 < m_c \leq m_3$. The **maximum refrigerant charge** can be increased or the minimum room area can be reduced if the following requirements are met:

- ~~The appliance shall be provided with a **refrigerant detection** system according to Annex LL, or the fan shall operate continuously and the **airflow** shall be monitored continuously.~~
- 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; **100**
- 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 ~~may~~ can be limited by zoning dampers shall not be included in the determination of TA.

The minimum airflow shall be determined as:

$$Q_{\min} = 60 \times m_c / LFL \quad (\text{GG.21-24})$$

where

$Q_{\min}$ is the minimum **circulation airflow** circulated to the total conditioned space in m³/h;

m_c is the actual **refrigerant charge** for a single **refrigerating system** expressed in kg;

LFL is the **lower flammability limit** in kg/m³.

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:

$$m_{\max} = SFCF \times LFL \times H \times TA \quad (\text{GG.22-25})$$

or

the required minimum total conditioned room area $TA_{\min}$ of installed appliance with **refrigerant charge** m_c (kg) shall be in accordance with following:

$$TA_{\min} = m_c / (SF \times CF \times LFL \times H) \quad (\text{GG.23} \rightarrow 26)$$

where

~~SF is the safety factor of 0,50;~~

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.

~~The minimum additional mechanical ventilation and fresh air make up airflow shall be determined according to GG.8.3.~~

~~The additional mechanical ventilation shall exhaust to the outside or to an area such that the combined area exhausted to and the total conditioned area is greater than $TA_{\min}$.~~

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 ~~detected continuously or~~ monitored continuously. Within 10 seconds 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 ~~refrigerant~~ leak detection system

~~When a refrigerant detection system according to Annex LL operates, the following shall be initiated.~~

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 ~~of charge~~ 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.

~~The refrigerant detection system and controls shall maintain the above action until at least 5 min after the refrigerant detection system has reset. Building fire and smoke systems may override this function.~~

~~If the continuous operation of duct fan is employed, additional ventilation shall also be continuously operated.~~

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** ~~$m_1 < m_c \leq \text{number of indoor units} \times m_2$~~ , ~~not to exceed $4 \times m_2$~~ $m_1 < m_c \leq m_3$. **101**

For appliances with more than one indoor unit, individual indoor unit cooling capacity shall not exceed 35 kW when tested in accordance with ISO 5151, ISO 13253, or ISO 15042 at T1 conditions. For heating only appliances with more than one indoor unit, individual indoor unit heating capacity shall not exceed 35 kW when tested in accordance with ISO 5151, ISO 13253, or ISO 15042 at H1 conditions.

The ~~appropriate~~ applicable measures to be taken shall be ventilation (natural or mechanical), **safety shut-off valves** and safety alarm, in conjunction with ~~refrigerant leak detection systems~~ as specified in GG.10.2 ~~to GG.10.5~~. 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.10.32 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.10.3.12.2 Spaces except lowest underground floor of the building

~~Where the refrigerant charge does not exceed maximum refrigerant charge in GG.10.4, no additional measures are required.~~

~~Where the charge exceeds the maximum refrigerant charge in GG.10.4 but is less than or equal to the maximum refrigerant charge in GG.10.5, then at least one additional measure shall be taken in accordance with Clause GG.11, GG.12, or GG.13.~~

~~Where the refrigerant charge exceeds the maximum refrigerant charge in GG.10.5, at least two additional measures are taken in accordance with Clause GG.11, GG.12, or GG.13.~~

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, GG.12 or 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 GG.12.

GG.10.3.2.3 Lowest underground floor of the building

~~Where the refrigerant charge exceeds the maximum refrigerant charge in GG.10.4, two additional measures shall be taken in accordance with Clause GG.11, GG.12, or GG.13.~~

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 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, GG.12 or GG.13.

The **refrigerant charge** shall not exceed the **maximum refrigerant charge** in GG.10.53.2.

GG.10.43 Maximum refrigerant charge

GG.10.3.1 Maximum refrigerant charge limit A

The **maximum refrigerant charge** $m_{\max}$ in a room and the ~~required~~ minimum room area $A_{\min}$ of the installed appliance with **refrigerant charge** m_c shall be in accordance with the following:

$$\del{m_{\max} = 0,25 \times LFL \times H \times A} \quad m_{\max} = CF \times LFL \times H_r \times A \quad (\text{GG.25}27)$$

$$\del{A_{\min} = m_c / (0,25 \times LFL \times H)} \quad A_{\min} = m_c / (CF \times LFL \times H_r) \quad (\text{GG.26}28)$$

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 is the room height in m but not more than 2,2 m unless h_0 as determined in Clause GG.2 is higher than 2,2 m;~~

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.10.53.2 Maximum refrigerant charge ~~when employing additional measures~~ limit B

The **maximum refrigerant charge**, $m_{\max}$, in a room and the minimum room area, $A_{\min}$ ~~are calculated~~, of the installed appliance with **refrigerant charge**, m_c , shall be in accordance with the following:

$$\del{m_{\max} = 0,50 \times LFL \times H \times A} \quad m_{\max} = CF \times LFL \times H_r \times A \quad (\text{GG.27}29)$$

$$\del{A_{\min} = m_c / (0,50 \times LFL \times H)} \quad A_{\min} = m_c / (CF \times LFL \times H_r) \quad (\text{GG.28}30)$$

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 is the room height in m but not more than 2,2 m unless h_0 as determined in Clause GG.2 is higher than 2,2 m;~~

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.10.24 Requirement for units with ~~incorporated~~ integral circulation airflow ~~to prevent stagnation~~**GG.10.24.1 General**

~~For indoor units where h_0 as determined in Clause GG.2 is less than 1,8 m, and for indoor units connected to one or more spaces by ducts which supply or return air from the space at a height less than 1,8 m, **circulation airflow** for the purpose of mixing the air in the room shall be provided. Where mechanical ventilation is required per Subclause GG.10.4 or Subclause GG.10.5, units where h_0 is equal or greater than 1,8 m, air circulation for the purpose of mixing the air in the room shall also be provided.~~

~~The circulation shall operate continuously or be turned on by **refrigerant detection systems**.~~
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:

$$v_{\min} = (-4,0 \times 10^{-5} \times M^2 + 0,0108 \times M + 1,42) / \sin \varphi \quad (\text{GG.24}31)$$

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 degrees is considered to be 15 degrees.

- 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 degrees and 90 degrees, 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.

~~Where a single remote refrigerant detection system sensor is used in a room with multiple units, this requirement shall apply to all units in the room which do not have a dedicated refrigerant detection system.~~

Operation of circulation airflow shall comply with either GG.10.4.2 or GG.10.4.3.

GG.10.24.2 Continuous circulation airflow

The indoor fan shall run continuously, other than for short periods for maintenance and service. The airflow shall be ~~detected continuously or~~ monitored continuously. Within 10 seconds 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.10.24.3 Circulation airflow initiated activated by a refrigerant leak detection system

~~When any refrigerant detection system is activated per Annex LL in response to a detected leak into the space, all indoor units in that room which are served by the same outdoor unit shall take the following actions and continue for at least 5 min:~~

- ~~— The fan shall be switched on.~~
- ~~— Disable the compressor operation unless the compressor operation reduces the leak rate or the total amount released to the indoor space.~~

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. ~~The indoor place used to provide ventilation air shall have sufficient volume, including the volume of the room in which the indoor unit is installed, to ensure that the maximum refrigerant charge specified in GG.10.4 is not exceeded.~~

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. **102**

$$A_{\min} = m_c / (CF \times LFL \times H_r) \quad (\text{GG.32})$$

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, ~~all of~~ 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.

~~For natural ventilation opening provided to an occupied space, the total area of the space in which the appliance is installed and the adjacent space which is connected by the natural ventilation shall have a room area more than $A_{\min}$ according to Clause GG.2 for m_c . If the total room area is not large enough, the measure of GG.11.3 shall be taken.~~

The minimum opening area for natural ventilation ($A_{nv,\min}$) to an indoor space shall be calculated using equation (GG.29):

$$A_{nv,\min} = \frac{1}{720 \times LFL} \times \sqrt{\frac{M}{LFL \times (M - 29)}}$$

$$A_{nv,min} = \frac{1}{720 \times LFL} \times \sqrt{\frac{M}{LFL \times (M - 29)}} \quad (\text{GG.29.33})$$

where

~~$A_{nv,min}$~~ $A_{nv,min}$ 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 equation is not applicable for refrigerants with a molar mass less than 42, as the equation is based on the principle that the density of the gases generates sufficient driving force to be successfully used with natural ventilation.~~

The minimum opening area for natural ventilation ($A_{nv,min}$) to an outdoor space shall be:

$$A_{nv,min} = 0,14 \times \sqrt{m_c \times \frac{0,04}{LFL}} \quad (\text{GG.34})$$

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 other 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, and for all indoor units in the same space which are served by a single refrigerating system, the fan shall be switched on to provide the minimum circulation airflow per GG.10.2.~~

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:

$$m_c = \frac{10 \times V}{Q} \ln \left(1 - \frac{Q \times 0,25 \times LFL}{10} \right) \quad m_c = - \frac{10 \times V}{Q_{min}} \ln \left(1 - \frac{Q_{min} \times 0,25 \times LFL}{10} \right) \quad (\text{GG.30.35})$$

For $(Q_{min} \times 0,25 \times LFL)/10 \geq 1$, the airflow shall be determined according to the following formula:

$$Q = \frac{10}{0,25 \times LFL} \quad Q_{\min} = \frac{10}{0,25 \times LFL} \quad (\text{GG.3136})$$

where

m_c is the **refrigerant charge**, expressed in kg;

V is the room volume in m³;

10 is the expected maximum leak rate in kg/h;

$Q_{\min}$ is the ventilation airflow in m³/h;

LFL is the **lower flammability limit** in kg/m³.

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. ~~For floor mounted units, openings shall be according to GG.8.3.3.~~

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.11.3.4 Operation of mechanical ventilation~~

~~Mechanical ventilation shall be operated continuously or shall be switched on by a refrigerant detection system.~~

GG.12 Safety shut-off valves for enhanced tightness refrigerating systems using A2L refrigerants

~~GG.12.1 Location~~

~~Safety shut-off valves shall be located in a space with a room volume large enough so that the maximum refrigerant charge complies with GG.10.4, GG.10.5, or outside.~~

Safety shut-off valves shall be positioned to enable access for maintenance by an authorized person.

~~GG.12.2 Design~~

~~Safety shut-off valves shall be designed to close in the event of an electric power failure, e.g. spring return solenoid valves.~~

~~If safety shut-off valves are used to comply with GG.10.4 or GG.10.5, then the released amount of refrigerant shall be limited to $0,5 \times LFL \times$ room volume.~~

~~The amount of refrigerant that can be leaked shall consider the response time of the sensor and the controller that activates the valves and the remaining amount of refrigerant that is contained in each section of the refrigerating system after the valves are closed.~~

~~NOTE Liquid migration in the off cycle may be the worst case condition for determination of the charge contained in the systems after closing of the safety shut-off valves.~~

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. 103

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 **refrigerant 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.

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Table GG.5 – Minimum ~~airflow~~ air velocity

Minimum ~~airflow~~ 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
< 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

Minimum ~~airflow~~ air velocity							
$v_{\min}$ (m/s)							
h_a (m)	M	Airflow angle above horizontal φ (degrees)					
		15	30	45	60	75	90
< 1,80	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
	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
> 1,80	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
	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

h_a is the air delivery height in upper side in m.

GG.14 Allowable charge for enhanced tightness refrigerating systems using A2 or A3 refrigerant 104

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** $m_1 < m_c \leq m_2$.

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; 105

$m_{\max}$ 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 m^2 ;

LFL is the **lower flammability limit**, in kg/m^3 .

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 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:

$$m_{\max} = CF \times LFL \times A \times 2,2 \quad (GG.41)$$

or the required minimum room area $A_{\min}$ of installed appliance with **refrigerant charge** m_c shall be in accordance with the following;

$$A_{\min} = m_c / (CF \times LFL \times 2,2) \quad (GG.42)$$

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 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 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:

$$Q_{\min} = 3\,600 \frac{5Y \sqrt{A_o} \dot{m}_{\text{leak}}^{3/4}}{h_o^{1/4} [LFL \times (1 - CF)]^{5/8}} \quad (GG.43)$$

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_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/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 $A_{\min}$. **106**

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 9.1. 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: **107**

$$\dot{m}_{\text{leak}} = \left(\frac{167}{432} \right) \dot{M}_s \quad (\text{GG.44})$$

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.

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 seconds 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.

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.

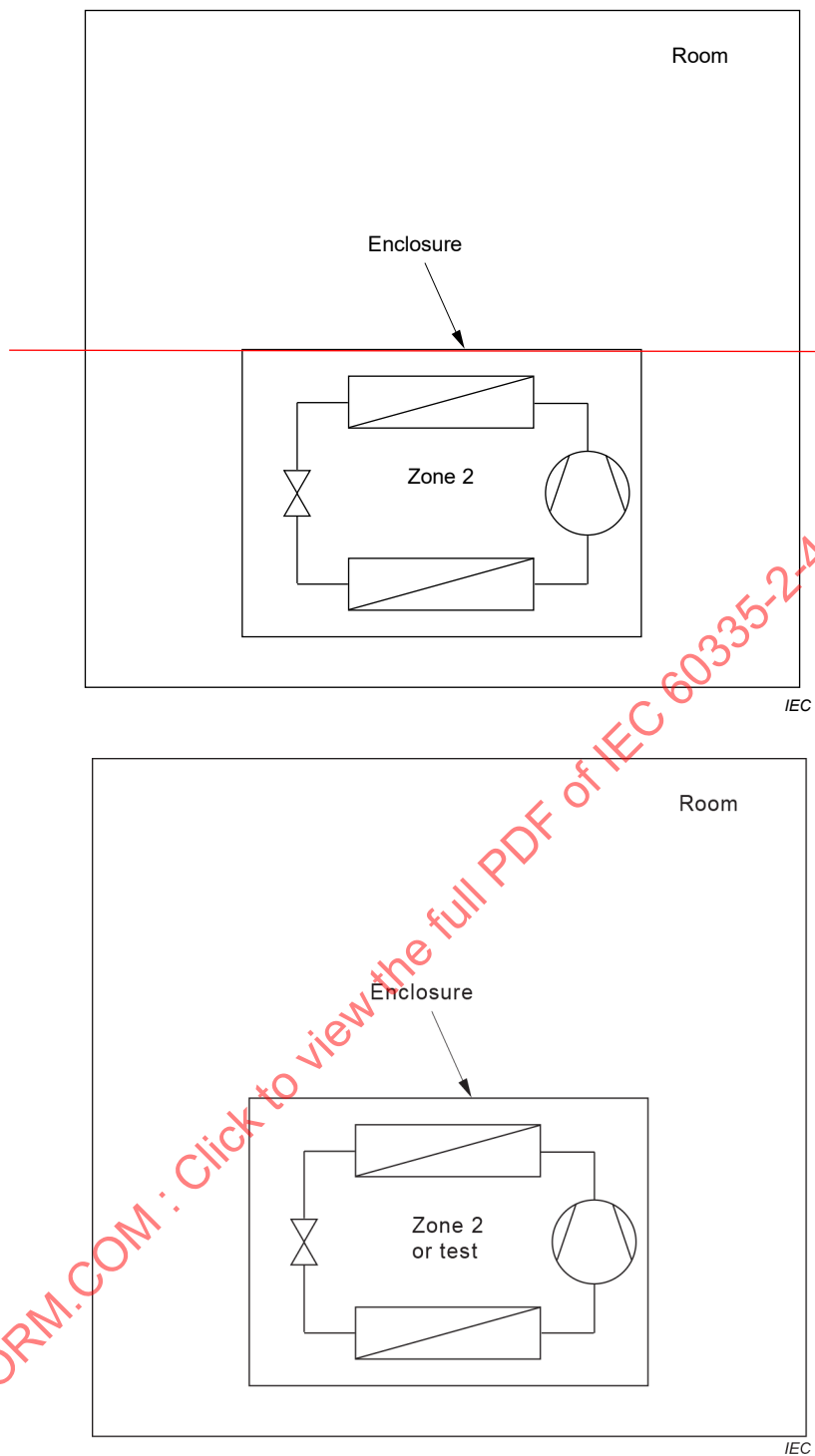


Figure GG.1 – Unventilated area

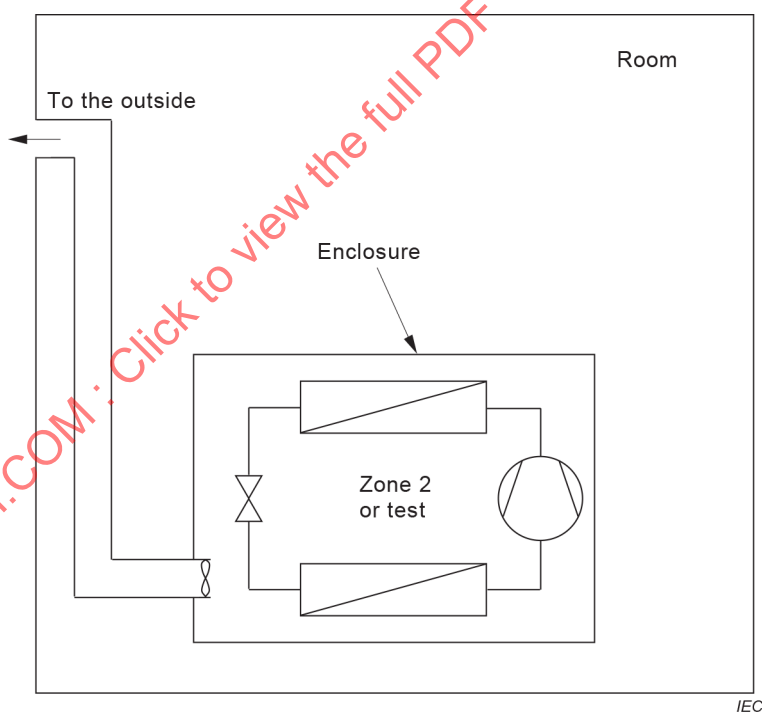
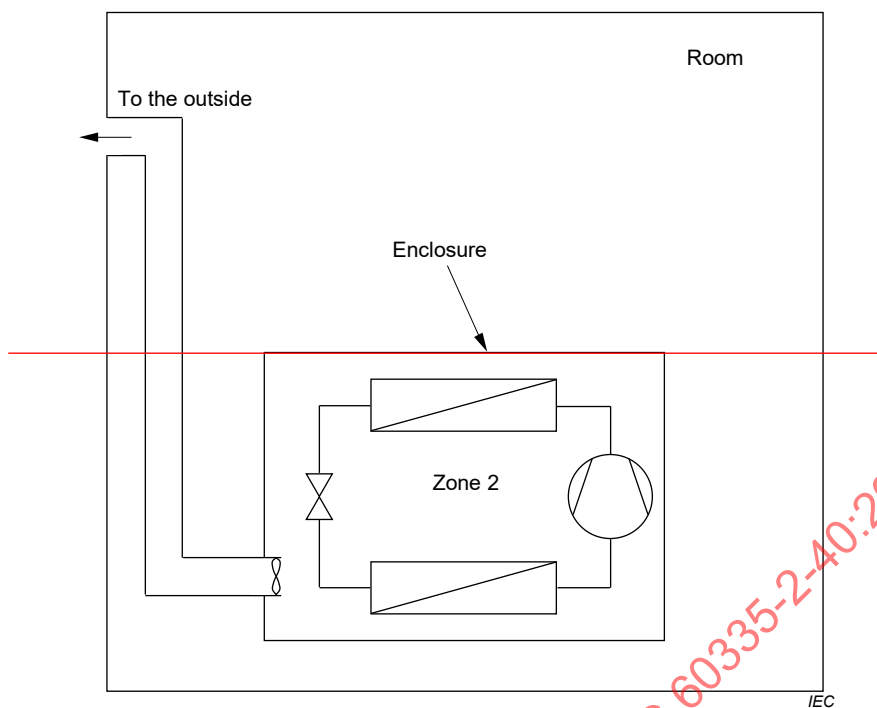


Figure GG.2 – Mechanical ventilation

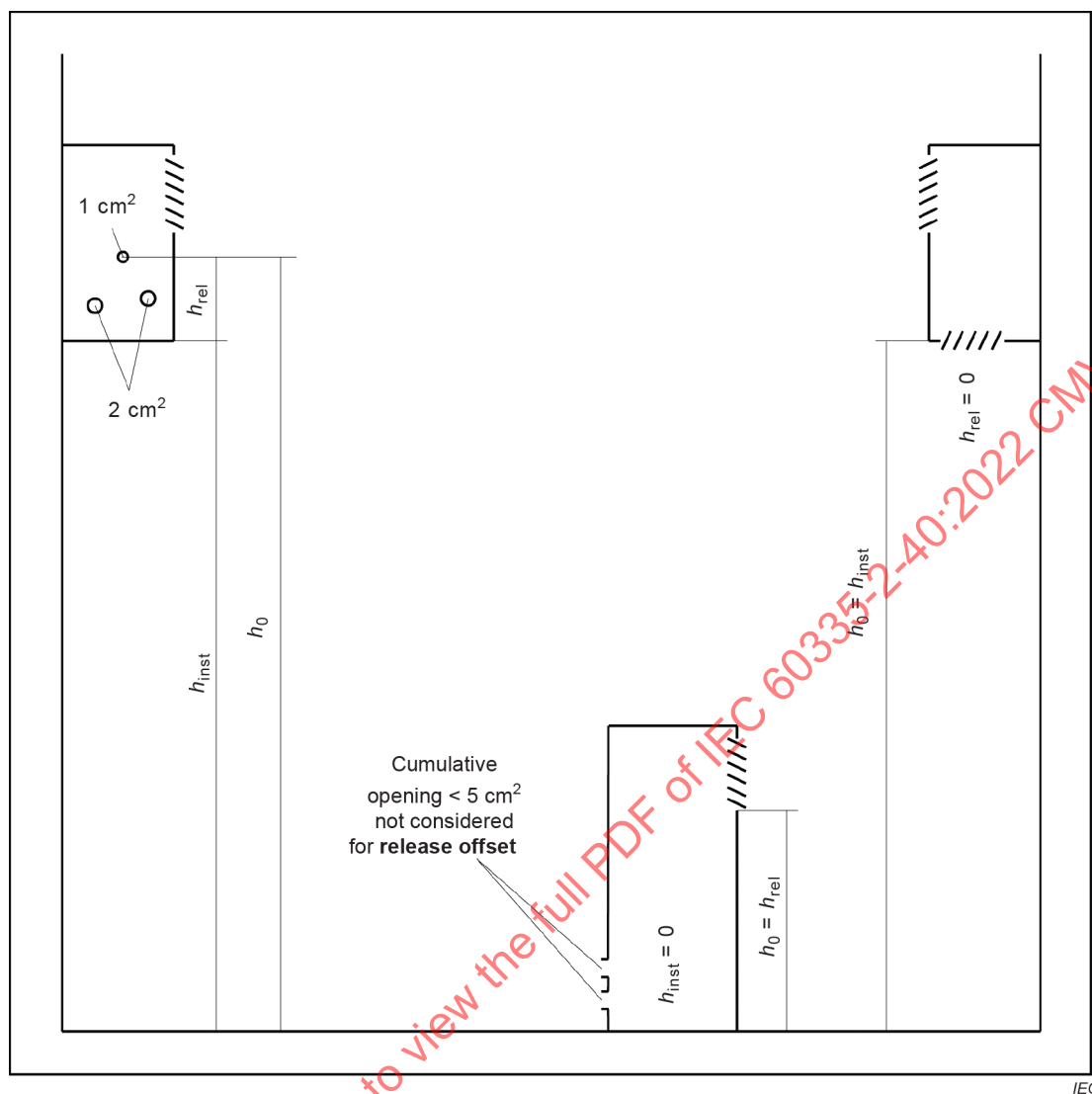
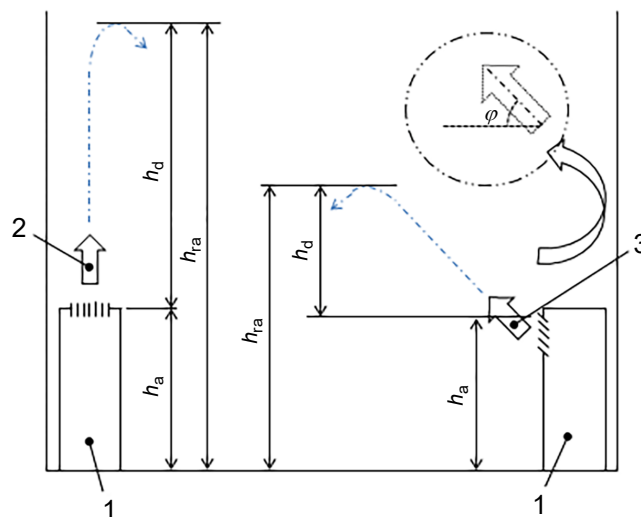


Figure GG.53 – Relevant heights h_{inst} , h_0 and h_{rel} for calculation of $A_{\min}$ and $m_{\max}$

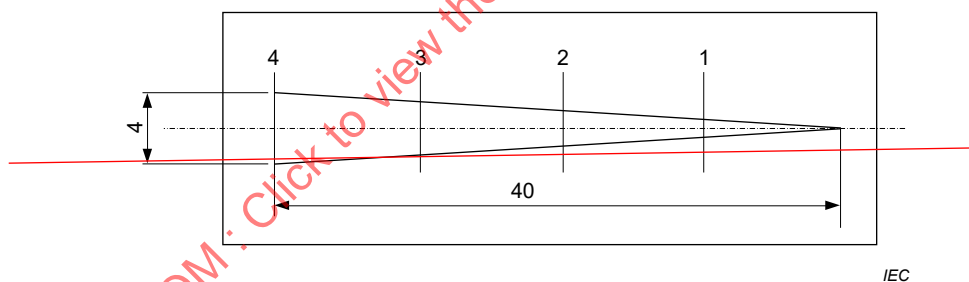


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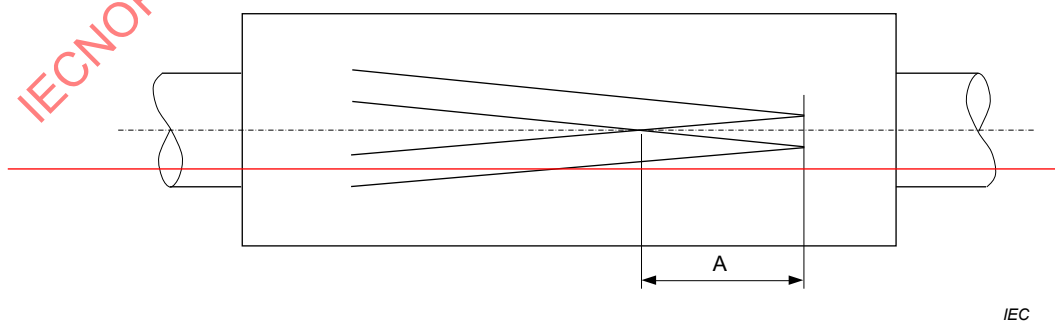
- 1 appliance
- 2 airflow direction: Upwards (vertical $\phi = 90^\circ$)
- 3 airflow direction: Upwards

Figure GG.64 – Airflow direction



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Figure GG.3 – Isosceles triangle arrow test gauge



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Figure GG.4 – Measurement of vibration amplitude

Annex HH (informative)

Competence of service personnel

HH.1 General

Information on procedures additional to 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 ~~national~~ training organisations or manufacturers that are ~~accredited~~ **competent** to teach the relevant national competency standards that ~~may~~ **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 ~~may~~ **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 ~~may~~ **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 concept of sealed components and sealed enclosures according to IEC 60079-15:2010.~~

~~**HH.2.7**~~ **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 ~~may~~ can be caused by refrigerant loss and a refrigerant leak is possible.
- Discharge capacitors in a way that won't 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 ~~may~~ can be caused by refrigerant loss and a refrigerant leak is possible.
- Discharge capacitors in a way that won't 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. ~~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 drained refrigerant will not float back into the building.~~
 - ~~Evacuate the refrigerant circuit.~~
 - ~~Purge the refrigerant circuit with nitrogen for 5 min (not required for A2L refrigerants).~~
 - ~~Evacuate again (not required for A2L refrigerants).~~
 - ~~Remove parts to be replaced by cutting, not by flame.~~
 - ~~Purge the braze point with nitrogen during the brazing procedure.~~
 - 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 putted 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 ~~may~~ can be caused by refrigerant loss and a refrigerant leak is possible.
- Discharge capacitors in a way that won't 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 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 ~~nitrogen~~ inert gas for 5 min,
- evacuate again,
- fill with ~~nitrogen~~ inert gas up to atmospheric pressure,
- put a label on the equipment that the refrigerant is removed.

e) Disposal

- ~~Ensure sufficient ventilation at the working place.~~
- ~~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 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 nitrogen for 5 min.~~
 - ~~— Evacuate again.~~
 - ~~— Cut out the compressor and drain the oil.~~
- ~~Evacuate the refrigerant circuit.~~
- ~~Purge the refrigerant circuit with nitrogen for 5 min.~~
- ~~Evacuate again.~~
- ~~Cut out the compressor and drain the oil.~~
- Follow national regulations.

Annex II
(Void)

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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**. **108**

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:

$$d_{\text{eff}} < 22,3 \times S_u^{-1,09} \quad (\text{in mm}) \leq 7 \text{ mm} \quad (\text{JJ.2})$$

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.

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Annex KK (normative)

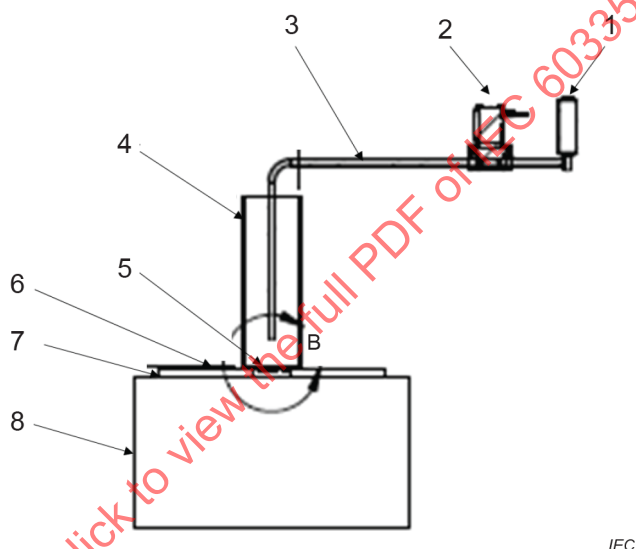
Test method for hot surface ignition temperature for A2L

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 "Standard Test Method for Discrimination Between Flammability Ratings of $F = 0$ and $F = 1$ ". The ASTM test is designed for automotive fluids as a pass fail test at 815 °C. This annex is concerned with liquefied refrigerants and defining the maximum no ignition temperature.

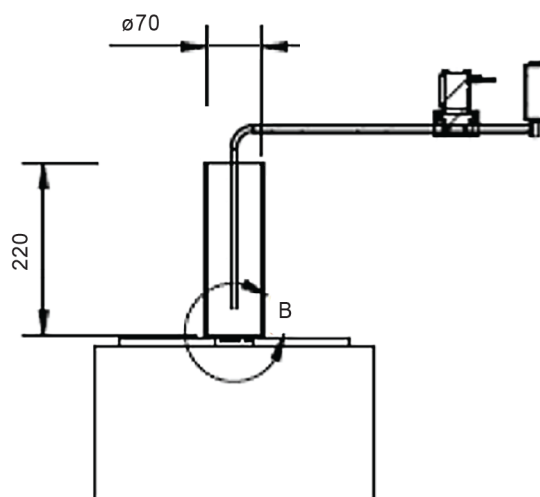


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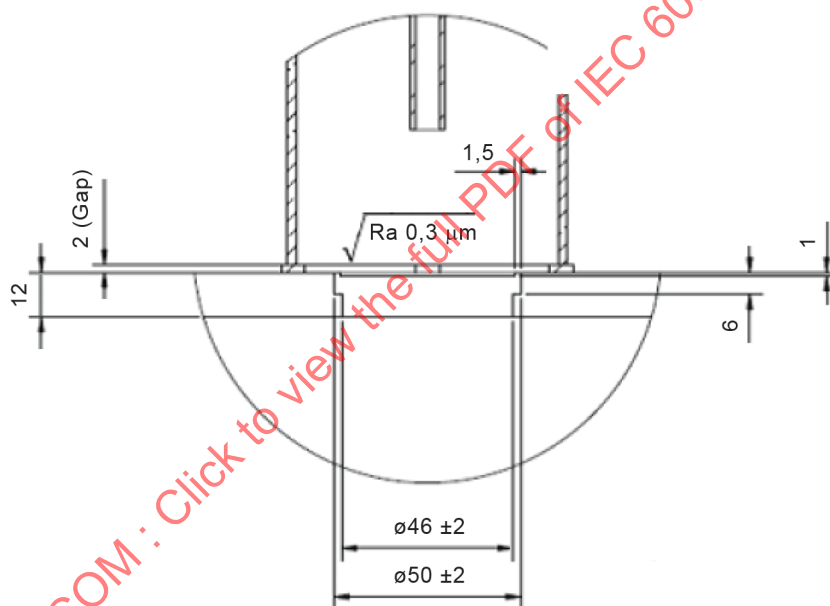
- 1 refrigerant cylinder with valve
- 2 valve
- 3 spray tube
- 4 glass cylinder
- 5 ~~planchet~~ metal disc
- 6 thermocouple
- 7 insulation
- 8 hot plate

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

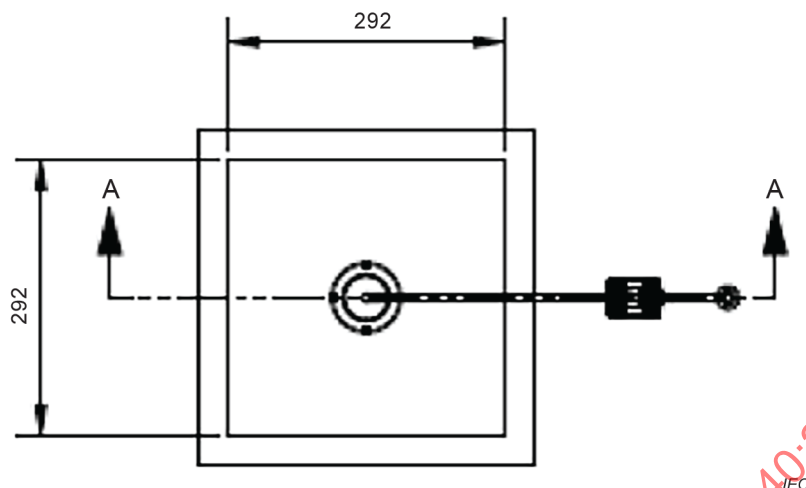


Figure KK.3 – Top view of test apparatus

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 ~~thermal couple~~ 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 at 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 $\pm 15\text{ }^{\circ}\text{C}$ of the set-point during the test.
- b) Refrigerant used for the test shall be the nominal composition (NC) per 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 given 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 $800\text{ }^{\circ}\text{C}$. If ignition occurs, then the plate temperature is to be reduced in increments of $20\text{ }^{\circ}\text{C}$ 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 highest temperature with no ignition in five trials.

Annex LL (normative)

Refrigerant detection systems for ~~A2L~~ flammable refrigerants

~~LL.1 General~~

~~Refrigerant detection systems shall be set to be activated before the refrigerant concentration reaches 25 % of the **LFL**. Where **LFL** is referenced in this annex, the **LFL** shall be taken at WCF—Worst Case Formulation as specified in ISO 817.~~

~~LL.2 Function of the refrigerant detection systems~~

~~The **refrigerant detection systems** shall be capable of detecting a pre-set level of the refrigerant concentration of the refrigerant that the sensor is designated to be used with and initiate the operation as defined in Annex GG.~~

~~LL.3 Refrigerant detection system range, accuracy and response time~~

~~**Refrigerant detection system** shall make output according to the applicable clauses of Annex GG of this standard within 30 s when the sensor is put into refrigerant concentration of 25 % of **LFL** or lower.~~

~~The **refrigerant detection system**, including the sensors, shall comply with the above requirements over the full range of operating temperature and humidity as specified by the appliance manufacturer.~~

~~Compliance is checked by test.~~

~~LL.4 Refrigerant detection system calibration~~

~~The **refrigerant detection systems** shall be pre-set and calibrated (with an accuracy of ± 20 %) from the factory for the refrigerant used.~~

~~LL.5 Electrical outputs for refrigerant detection system~~

~~The device shall have an output in accordance with the applicable clauses of Annex GG of this standard.~~

~~LL.6 Vibration requirements~~

~~A sensor shall withstand vibration without breakage or damage of parts and shall continue to function. The vibration parameters shall be defined based on the intended application and expected transportation. If vibration operating parameters are not established by the manufacturer, then a sample of the sensor shall be subject to the requirements defined below.~~

~~To comply with the vibration requirements, two samples shall be secured to the intended mounting and in turn securely fastened to a variable speed vibration test machine having an amplitude and frequency as follows:~~

- ~~• 10 Hz to 31,5 Hz, with 1,0 mm total excursion, and~~
- ~~• 31,5 Hz to 150 Hz, with 2 g acceleration peak.~~

~~The samples shall be vibrated over the specified frequency range, displacement and acceleration for a period of 1 h in each of the three mutually perpendicular planes. The change rate shall not exceed 10 Hz/min. After the samples are vibrated, they shall be tested to verify they still sense refrigerant at 25 % of LFL or lower.~~

~~LL.7 Refrigerant detection system self-test routine~~

~~The detection system shall include a means for self testing the sensor to determine the output is at proper range. The test shall be run at least every hour and if a failure is detected, an alarm shall be activated.~~

~~If the sensor has a defined life and requires replacement after a given period, then the detection system shall initiate an alarm or indication that replacement is required. If sensor becomes more sensitive with aging to generate false alarm, the end of life alarm can be omitted.~~

~~Compliance is checked by inspection.~~

~~LL.8 Sensor identification~~

~~The sensors shall be marked with~~

- ~~• name, trade mark or identification mark of the manufacturer or responsible vendor;~~
- ~~• model or type reference.~~

~~Compliance is checked by inspection.~~ 109

LL.1 General

This annex applies to **refrigerant detection systems** for use in appliances using **flammable refrigerants**.

Refrigerant detection systems shall give an output signal at a predetermined alarm set point in response to leaked refrigerant.

Refrigerant detection systems may respond directly to the refrigerant concentration or may respond to gases being displaced by the refrigerant.

In this annex, where **LFL** is referenced and for refrigerant used for all tests, the composition shall be the nominal composition as specified in Annex BB.

The **refrigerant detection systems** shall be capable of detecting refrigerant concentration above the alarm set point, for the refrigerant marked on the appliance, over the full range of operating temperature and humidity as specified by the appliance manufacturer. Worst case combined effects of declared manufacturing tolerances and drift shall be considered.

The tests of Clauses LL.5, LL.6, LL.7, and LL.11 are carried out on 3 separate samples for each clause; these samples shall not be used for other tests. All samples shall pass the tests.

The tests in other clauses of Annex LL shall be done with 3 samples and the tests are carried out in the following order: Clause LL.4, Clause LL.8, Clause LL.9, Clause LL.10, Clause LL.3. All samples shall pass the tests.

LL.2 Test gases and default test conditions

For the test in Clause LL.3, the test gas shall be 24 % to 25 % of **LFL**.

For the test in Clause LL.4, the low ratio test gas shall be $(3 \pm 0,3)$ % of **LFL** below the alarm set point declared by the manufacturer, but no lower than $(1,1 \pm 0,1)$ % of **LFL**.

For the test in Clause LL.4, the high ratio test gas shall be $(3 \pm 0,3)$ % of **LFL** above the alarm set point declared by the manufacturer, but no higher than $(24,7 \pm 0,3)$ % of **LFL**.

For the tests in LL.5.9, Clause LL.6, Clause LL.7, Clause LL.8, Clause LL.9, and Clause LL.10, the low ratio test gas shall be $(6 \pm 0,6)$ % of **LFL** below the alarm set point declared by the manufacturer, but no lower than $(1,1 \pm 0,1)$ % of **LFL**.

For the tests in LL.5.9, Clause LL.6, Clause LL.7, Clause LL.8, Clause LL.9, and Clause LL.10, the high ratio test gas shall be $(6 \pm 0,6)$ % of **LFL** above the alarm set point declared by the manufacturer, but no higher than $(24,7 \pm 0,3)$ % of **LFL**.

Table LL.1 illustrates the relationship between alarm set point, tolerances, and test gas concentrations.

For the test in Clause LL.11, the test gas shall be $(110 \pm 0,5)$ % of the stoichiometric concentration.

The test shall be made in a test gas chamber which construction shall be such as to ensure that the apparatus is exposed to a specific volume ratio of test gas in a reproducible manner.

Unless otherwise specified, the following conditions shall be maintained within the test gas chamber:

- *at constant temperature ± 2 °C within the range 15 °C to 25 °C throughout the duration of each test;*
- *at constant relative humidity ± 10 % RH within the range 30 % RH to 70 % RH throughout the duration of each test;*
- *at constant pressure ± 1 kPa within the range of 86 kPa to 108 kPa throughout the duration of the test.*

Table LL.1 – Relationship among alarm set point, tolerance and test gas (informative)

Alarm set point	Clause LL.4						Subclause LL.5.9, Clause LL.6 , Clause LL.7, Clause LL.8, Clause LL.9, and Clause LL.10					
	Tolerance of refrigerant detection system: $\pm 2,5$ % of <i>LFL</i>		Low ratio test gas: $(3 \pm 0,3)$ % of <i>LFL</i> below the alarm set point, but no lower than $(1,1 \pm 0,1)$ % of <i>LFL</i>		High ratio test gas: $(3 \pm 0,3)$ % of <i>LFL</i> above the alarm set point, but no higher than $(24,7 \pm 0,3)$ % of <i>LFL</i>		Tolerance of refrigerant detection system: $\pm 5,0$ % of <i>LFL</i>		Low ratio test gas: $(6 \pm 0,3)$ % of <i>LFL</i> below the alarm set point, but no lower than $(1,1 \pm 0,1)$ % of <i>LFL</i>		High ratio test gas: $(6 \pm 0,3)$ % of <i>LFL</i> above the alarm set point, but no higher than $(24,7 \pm 0,3)$ % of <i>LFL</i>	
	Lower limit	Upper limit	Low ratio test gas, min.	Low ratio test gas, max.	High ratio test gas, min.	High ratio test gas, max.	Lower limit	Upper limit	Low ratio test gas, min.	Low ratio test gas, max.	High ratio test gas, min.	High ratio test gas, max.
% <i>LFL</i>	% <i>LFL</i>	% <i>LFL</i>	% <i>LFL</i>	% <i>LFL</i>	% <i>LFL</i>	% <i>LFL</i>	% <i>LFL</i>	% <i>LFL</i>	% <i>LFL</i>	% <i>LFL</i>	% <i>LFL</i>	% <i>LFL</i>
1,0	1,0	3,5	1,0	1,2	3,7	4,3	1,0	6,0	1,0	1,2	6,7	7,3
2,0	1,0	4,5	1,0	1,2	4,7	5,3	1,0	7,0	1,0	1,2	7,7	8,3
3,0	1,0	5,5	1,0	1,2	5,7	6,3	1,0	8,0	1,0	1,2	8,7	9,3
4,0	1,5	6,5	1,0	1,3	6,7	7,3	1,0	9,0	1,0	1,2	9,7	10,3
5,0	2,5	7,5	1,7	2,3	7,7	8,3	1,0	10,0	1,0	1,2	10,7	11,3
6,0	3,5	8,5	2,7	3,3	8,7	9,3	1,0	11,0	1,0	1,2	11,7	12,3
7,0	4,5	9,5	3,7	4,3	9,7	10,3	2,0	12,0	1,0	1,3	12,7	13,3
8,0	5,5	10,5	4,7	5,3	10,7	11,3	3,0	13,0	1,7	2,3	13,7	14,3
9,0	6,5	11,5	5,7	6,3	11,7	12,3	4,0	14,0	2,7	3,3	14,7	15,3
10,0	7,5	12,5	6,7	7,3	12,7	13,3	5,0	15,0	3,7	4,3	15,7	16,3
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13,0	10,5	15,5	9,7	10,3	15,7	16,3	8,0	18,0	6,7	7,3	18,7	19,3
14,0	11,5	16,5	10,7	11,3	16,7	17,3	9,0	19,0	7,7	8,3	19,7	20,3
15,0	12,5	17,5	11,7	12,3	17,7	18,3	10,0	20,0	8,7	9,3	20,7	21,3
16,0	13,5	18,5	12,7	13,3	18,7	19,3	11,0	21,0	9,7	10,3	21,7	22,3
17,0	14,5	19,5	13,7	14,3	19,7	20,3	12,0	22,0	10,7	11,3	22,7	23,3
18,0	15,5	20,5	14,7	15,3	20,7	21,3	13,0	23,0	11,7	12,3	23,7	24,3
19,0	16,5	21,5	15,7	16,3	21,7	22,3	14,0	24,0	12,7	13,3	24,4	25,0
20,0	17,5	22,5	16,7	17,3	22,7	23,3	15,0	25,0	13,7	14,3	24,4	25,0
21,0	18,5	23,5	17,7	18,3	23,7	24,3	16,0	25,0	14,7	15,3	24,4	25,0
22,0	19,5	24,5	18,7	19,3	24,4	25,0	17,0	25,0	15,7	16,3	24,4	25,0
23,0	20,5	25,0	19,7	20,3	24,4	25,0	18,0	25,0	16,7	17,3	24,4	25,0
24,0	21,5	25,0	20,7	21,3	24,4	25,0	19,0	25,0	17,7	18,3	24,4	25,0
25,0	22,5	25,0	21,7	22,3	24,4	25,0	20,0	25,0	18,7	19,3	24,4	25,0

LL.3 Response time of the refrigerant detection system

Refrigerant detection system shall give an output signal within 30 seconds when the **refrigerant sensor** is put into refrigerant concentration of 25 % of *LFL*.

Compliance is checked by test.

*The test shall be conducted after the warm-up time for the **refrigerant sensor** has elapsed.*

*Expose the **refrigerant sensor** to a step change in the gas volume ratio from clean air to the test gas specified in Clause LL.2 within 5 s.*

*The **refrigerant detection system** shall give an output signal within 30 seconds after the step change is completed.*

*Expose the **refrigerant sensor** to clean air. If the **refrigerant detection system** gives an output signal indicating a leak after 5 hours of exposure to clean air, then the **refrigerant detection system** or the appliance shall provide notification to the user that replacement of the **refrigerant sensor** is required (see also 22.122). 110*

The samples shall not be used for subsequent tests.

LL.4 Refrigerant detection system calibration and short-term stability

The **refrigerant detection systems** shall have an alarm set point and be calibrated from the factory for the refrigerant marked on the appliance.

The **refrigerant detection system** shall consistently give an output signal at the alarm set point with a tolerance of $\pm 2,5$ % of **LFL**, but not lower than 1 % of **LFL**.

The alarm set point shall not be adjustable. Recalibration other than self-recalibration shall not be allowed. 111

Compliance is checked by inspection and test.

*To confirm the pre-set alarm set point, the **refrigerant detection system** shall respond as intended when tested as follows:*

- *The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal within this time.*
- *The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal within this time.*

Repeat twice after the initial test with a 5 min interval between tests.

LL.5 Selectivity test and poisoning test

LL.5.1 Refrigerant detection system including **refrigerant sensors** shall not have false or nuisance trips, and not be subject to poisoning.

After being exposed to the gases in Table LL.2, the **refrigerant detection system** shall consistently give an output signal at the alarm set point with a tolerance of ± 5 % of **LFL**, but not lower than 1 % of **LFL**.

Compliance is checked by the following test.

LL.5.2 *The **refrigerant sensor** shall be exposed sequentially, as described in LL.5.4 to LL.5.8, to the concentrations of gases and vapours shown in Table LL.2.*

Table LL.2 – Gas and vapour concentrations 112

Substance	Concentration, ppm
Methane	500
n-Butane	300
n-Heptane	500
Ethyl acetate	200
Isopropyl alcohol	200
Carbon dioxide	5 000
Ammonia	100
Ethanol	200
Toluene	200
Acetone	200
Hexamethyldisiloxane	110
ppm: parts per million.	

LL.5.3 Based on the interior volume of the test chamber used in LL.5.1, calculate the amount of each test substance necessary to supply the concentrations given in Table LL.2.

LL.5.4 Ensure that the chamber has been well ventilated with fresh air. Place the **refrigerant sensor** in operation inside the chamber and allow it to run for 15 minutes $\pm$ 5 minutes. Close and seal the chamber to prevent air infiltration.

LL.5.5 Using a syringe or equivalent device, add the calculated amount of the first substance into the chamber at a rate and in a location such that it is well mixed with the air and does not cause localized high concentrations.

LL.5.6 Allow the **refrigerant sensor** to remain in the chamber for 2 hours. During this time, the output signal shall not indicate the presence of refrigerant concentration above the alarm set point.

LL.5.7 Purge the chamber with clean air to remove all of the test atmosphere. Maintain clean air in the chamber for a recovery time of 16 hours or as specified by the manufacturer. In no case shall recovery time exceed 16 hours.

LL.5.8 Reseal the chamber and repeat the test using another substance from Table LL.2 until the **refrigerant sensor** has been exposed to all substances. It is not required that exposure to the substances be in any particular order.

LL.5.9 At the end of the test:

- The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal within this time.
- The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal within this time.

LL.6 Refrigerant poisoning and oil spray test 113

LL.6.1 General

The **refrigerant detection system** shall not be subject to poisoning or damage by the refrigerant(s) marked on the appliance mixed with oil.

After being exposed to the refrigerant(s) marked on the appliance mixed with oil, the **refrigerant detection system** shall

- consistently give an output signal at the alarm set point with a tolerance of $\pm 5\%$ of **LFL**, but not lower than 1% of **LFL**, and shall give an output signal within 60 seconds when the **refrigerant sensor** is put into refrigerant concentration of 25% of **LFL**, or
- give an output signal indicating a refrigerant leak and notify the user that the **refrigerant sensor** needs to be replaced. The output signal shall continue until the **refrigerant sensor** has been replaced.

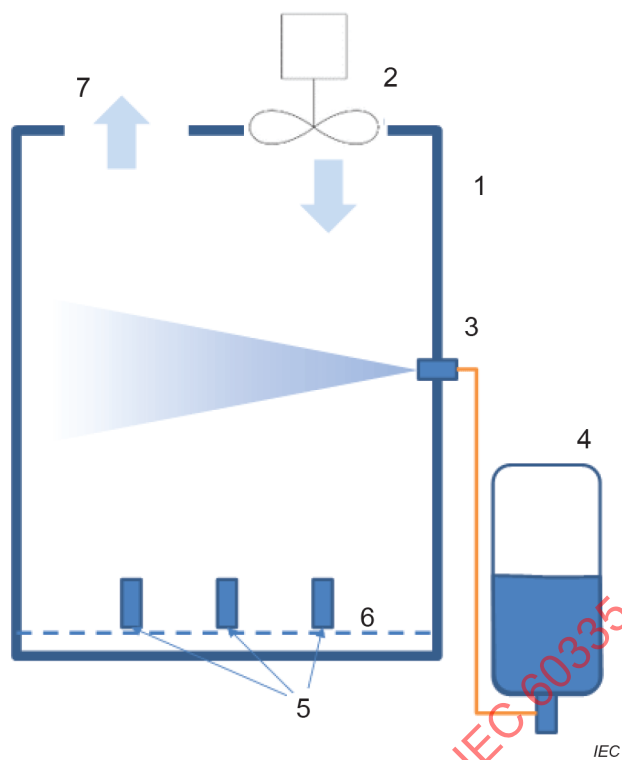
LL.6.2 Test set-up

- a) The test vessel shall be cylindrical shape and have enough bottom area to accommodate 3 sample **refrigerant sensors** to be placed without contact at bottom level.
- b) The **refrigerant sensors** shall be placed in the vessel on a grid that is $2\text{ cm} \pm 0,5\text{ cm}$ above the bottom of the vessel with orientation in accordance with the manufacturer's instructions.
- c) Height of the vessel shall be greater than the diameter of the vessel, but less than 2 times the diameter.
- d) An orifice size shall be chosen to release refrigerant at a rate of $200\% \pm 20\%$ of the vessel volume per minute, based on $0,022\text{ 4 m}^3/\text{mol}$.
- e) The orifice shall be located at the middle of the vessel height and directed to make a horizontal release of refrigerant.
- f) Liquid refrigerant shall contain $2\% \pm 0,2\%$ of oil to be used in the appliance or other miscible oil with the refrigerant between 15°C and 30°C .
- g) The refrigerant and oil mixture shall be taken from the liquid phase.

NOTE 1 This can be accomplished by using a refrigerant cylinder with a dip tube or the refrigerant cylinder can be placed upside down to ensure the release is taken from the liquid phase.

- h) The total amount of refrigerant per release with lubricant shall be $800\% \pm 80\%$ of the vessel volume, based on $0,022\text{ 4 m}^3/\text{mol}$.
- i) A ventilation fan with nominal flow rate to dilute the released refrigerant to $50\% \pm 10\%$ of **LFL** shall be provided at the top plate of the vessel to introduce fresh air to the vessel.
- j) The output signal of one **refrigerant detection system** shall be wired to make the ventilation fan operate 15 seconds after the **refrigerant detection system** gives an output.
- k) An exhaust opening shall be provided, also at the top plate of the vessel, to have velocity less than 1 m/s based on the nominal airflow rate of the fan. The exhaust opening shall have a minimum area of 100 cm^2 .

NOTE 2 An example of a test set-up design is given in Figure LL.1 and Table LL.3.



Key

- 1 test vessel
- 2 fan
- 3 spray orifice
- 4 cylinder for refrigerant-oil mix
- 5 test samples
- 6 floor grid (raised from floor)
- 7 exhaust opening

Figure LL.1 – Example of test chamber design

Table LL.3 – Example of the test chamber design

Vessel volume	20 L (5 gal) pail
Refrigerant	R-32 (Molar mass 52 kg/kmol; LFL 0,306 kg/m ³)
Release rate	1,5 g/s Verification: 1,5 g/s is $1,5 \times 60 = 90$ g/min, this is $90 / 52 = 1,73$ mol/min, or $1,73 \times 0,0224 = 0,0388$ m³/min. - In % of vessel volume 1,5 g/s is $0,0388 / 0,02 \times 100 = 194$ % of vessel volume per minute. - This is within the accepted tolerance range.
Release amount	360 g including (7,2 ± 0,72) g of lubricant Released in approximately 4 minutes (total amount has priority than the release duration)
Ventilation rate	0,6 m ³ /min Verification: - The required ventilation is $1,5 \text{ g/s} \times 0,001 \text{ kg/g} \times 60 \text{ s/min} / (0,50 \times 0,306 \text{ kg/m}^3) = 0,588 \text{ m}^3/\text{min}$. - The ventilation rate is within the accepted tolerance range.
Opening area for exhaust	Square opening 100 mm × 100 mm, or round opening with 112 mm diameter.
Orifice size	Diameter 0,8 mm to 1,0 mm

LL.6.3 Test procedure

A set-up according to LL.6.2 shall be provided.

- Start the release of refrigerant with oil at the specified rate.
- The ventilation fan shall be activated 15 seconds after the **refrigerant detection system** gives an output signal.
- Maintain the release of refrigerant with oil until the specified amount is released. This will take approximately 4 minutes from the start of the release.
- Maintain the ventilation fan operation at least 5 minutes after the reset of the **refrigerant detection system**.
- If the **refrigerant detection system** or the appliance provides notification to the user that replacement of the **refrigerant sensor** is required (see also 22.122), then the **refrigerant detection system** shall give an output signal indicating a leak until the **refrigerant sensor** has been replaced (see also 22.122) and the test shall be terminated.
- Stop ventilation fan.
- Test according to LL.6.4.
- Repeat steps of a) to g) for a total of 5 times.

LL.6.4 Check of alarm set point and response time

The **refrigerant detection system** shall respond as intended when tested as follows:

- The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal.
- The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal.
- Expose the **refrigerant sensor** to clean air for (15 ± 5) minutes.

- d) Expose the **refrigerant sensor** to a step change in the gas volume ratio from clean air to 24 % to 25 % of **LFL** within 5 s.
- e) The **refrigerant detection system** shall give an output signal within 60 seconds after the step change is completed.

LL.7 Long term stability

Over a period of 90 days, the **refrigerant detection system** shall consistently give an output signal at the alarm set point with a tolerance of ± 5 % of **LFL**, but not lower than 1 % of **LFL**.

Compliance is checked by the following test:

The **refrigerant sensor** shall be exposed to clean air and energized continuously for a period of 90 days. The constant pressure requirement of Clause LL.2 shall not apply to this test. Every 15 days:

- The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal within this time.
- The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal within this time.

LL.8 Humidity test 114

Over the humidity range of the appliance, the **refrigerant detection system** shall consistently give an output signal at the alarm set point with a tolerance of ± 5 % of **LFL**, but not lower than 1 % of **LFL**.

NOTE Condensation can occur on refrigerant sensors. This is not considered by Annex LL.

Compliance is checked by the following test:

The **refrigerant sensor** shall be exposed for 60 min to clean air humidified to (30 ± 5) % RH at (15 ± 2) °C.

To confirm the pre-set alarm set point, the **refrigerant detection system** shall respond as intended when tested as follows:

- The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal within this time.
- The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal within this time.

The test gases of Clause LL.2 shall also be humidified.

The procedure shall be repeated with (90 ± 5) % RH at (40 ± 2) °C.

LL.9 Temperature test 115

Over the temperature range of the appliance, the **refrigerant detection system** shall consistently give an output signal at the alarm set point with a tolerance of ± 5 % of **LFL**, but not lower than 1 % of **LFL**.

Compliance is checked by the following test:

Place the **refrigerant sensor** in operation inside a chamber having the capability of holding the **refrigerant sensor** at the specified temperatures within ± 2 K. The **refrigerant sensor** shall be acclimated at each of the following temperatures for at least 3 h or until acclimated within ± 2 K for a minimum of 1 h:

- the minimum temperature that the refrigerant sensor can be exposed to in the application as declared by the manufacturer or lower;
- the maximum temperature that the refrigerant sensor can be exposed to in the application as declared by the manufacturer or higher.

To confirm the pre-set alarm set point at each temperature, the **refrigerant detection system** shall respond as intended when tested as follows:

- The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal within this time.
- The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal within this time.

LL.10 Vibration requirements 116

Vibration requirements this clause apply for **refrigerant sensors**. Vibration requirements for **refrigerant sensors** need not apply to the entire appliance.

Refrigerant sensors shall withstand vibration without breakage or damage of parts and shall continue to function.

After the vibration test, the refrigerant detection system shall give an output signal at the alarm set point with a tolerance of ± 5 % of **LFL**, but not lower than 1 % of **LFL**.

Compliance is checked by the following test:

The **refrigerant sensor** shall be secured to the intended mounting and in turn securely fastened to a variable speed vibration test machine having an amplitude and frequency as follows:

- 10 Hz to 31,5 Hz, with 1,0 mm total excursion, and
- 31,5 Hz to 150 Hz, with 2 g acceleration peak.

The **refrigerant sensor** shall be vibrated over the specified frequency range, displacement and acceleration for a period of 1 h in each of the three mutually perpendicular planes. The change rate shall not exceed 10 Hz/min.

Alternatively, the **refrigerant sensor** may be tested using the vibration test of 21.101. 117

After the vibration test, the **refrigerant detection system** shall respond as intended when tested as follows:

- The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal within this time.
- The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal within this time.

LL.11 Ignition test 118

Refrigerant sensors shall not be a source of ignition for leaked refrigerant.

Compliance is checked by test.

*The test shall be conducted after the warm-up time for the **refrigerant sensor** has elapsed.*

*Expose the **refrigerant sensor** to a step change in the gas volume ratio from clean air to the test gas specified in Clause LL.2 within 5 s.*

For compliance, no explosion nor ignition shall occur within 5 min.

LL.12 Refrigerant detection system self-test routine 119

The **refrigerant detection system** shall include a means for self-testing to determine if a **refrigerant sensor** electrical malfunction has occurred. The self-test shall include missing **refrigerant sensor** (open circuit), by-passed **refrigerant sensor** (shorted circuit), and **refrigerant sensor** output out of range.

The test shall be run at least every hour and if a failure is detected, the **refrigerant detection system** shall provide a dedicated notification to the end user that replacement is required.

If the **refrigerant sensor** is a **limited life refrigerant sensor** and requires replacement after a given period, then the **refrigerant detection system** shall provide notification to the user that replacement is required at the end of the specified life.

Compliance is checked by inspection.

LL.13 Serviceability

Refrigerant sensors shall be accessible for inspection and replacement. **Refrigerant sensors** for replacement shall be specified by the appliance manufacturer.

Compliance is checked by inspection.

LL.14 Refrigerant sensor identification 120

The **refrigerant sensors** or the parts of the appliance containing **refrigerant sensors** shall be marked or tagged with:

- "service indicator; read technical manual" (symbol ISO 7000-1659 (2004-01));
- year of manufacturing;
- reference number or other means for identifying the **refrigerant sensor**.

The marking shall be visible when servicing the **refrigerant sensors**.

Compliance is checked by inspection.

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 121

MM.2.1 General

~~The appliance is modified by introducing a simulated leak through a capillary tube. The leak rate shall be maintained at m_x in g/s. The simulated leak is applied for 1 min.~~

~~$$m_x = 12,5 \times LFL \times V_{\text{free}}, \text{ but not less than } 5 \times LFL \times 1\,000/3\,600 \quad (\text{MM.1})$$~~

~~where~~

~~12,5 is the result of the conversion of kg/min to g/s and 75 % (of LFL)
 $1\,000/60 \times 0,75 = 12,5$;~~

~~m_x is the mass flow rate of the simulated leak in g/s, $\pm 5\%$;~~

~~LFL is the lower flammability limit in kg/m³;~~

~~V_{free} is the free volume of the internal space in the appliance below the simulated leak in m³.~~

~~The free volume (V_{free}) shall be determined by calculating the volume of the appliance bounded by a horizontal plane at the lowest point of the simulated leak, the appliance enclosure walls and the plane of the supply and return openings. The volume shall be reduced by the volume of components or enclosed compartments within the bounded space. Components and enclosed compartments within the bounded space with a volume of less than 0,001 m³ can be ignored.~~

~~A leakage of refrigerant in the **refrigerating system** is simulated at the unfavourable critical points for detection of the leak. A critical point is a joint in the refrigerant system tubing, a bend of more than 90 degrees, or other point judged to be a weak point in the refrigerant containing system due to the thickness of the metal, exposure to damage, sharpness of a bend or the manufacturing process, an unfavourable point is a 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 ambient temperature (15 °C to 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.~~

~~Gare 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.~~

~~MM.2.2 During this test, following appliance operating modes shall be tested;~~

~~— Fan OFF, and~~

~~— Fan ON.~~

~~If the minimum airflow specified by the manufacturer is not less than the minimum airflow specified in GG.2.2 or Clause GG.9, testing in the fan ON mode is not required.~~

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 m^3/h ;

LFL is the **lower flammability limit** in kg/m^3 ;

1 000 is the conversion factor from kg to g;

3 600 is the conversion factor from h to s.

MM.2.34 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 per instructions.

MM.2.4 The test is conducted in a room that is ~~draft~~ 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:

$$\del{A_t > 1,2 \times \dot{m}_F / (LFL \times h_t)} \quad A_t = 1,2 \times \dot{m}_{\text{leak}} / (LFL \times h_t) \quad (\text{MM.23})$$

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);

~~$\dot{m}_F$~~ $\dot{m}_{\text{leak}}$ 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 seconds refrigerant release at a release rate of ~~$\dot{m}_F$~~ $\dot{m}_{\text{leak}}$.

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 seconds (time constant 4,3 seconds) 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. ~~It shall be calibrated to have an accuracy of $\pm 1\%$ of gas concentration between 20 % and 30 % gas concentration.~~

~~For small products where an additional sensor cannot be built in, the evaluation of MM.2.6 shall suffice.~~

NOTE An oxygen sensor can be used for monitoring.

~~The refrigerant gas concentrations~~ sampling interval shall be ~~made at least every~~ 10 seconds 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 seconds 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 seconds from the start of the release, the **refrigerant detection system** **refrigerant sensor** location shall be considered in compliance.*

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Annex NN (normative)

Flame arrest enclosure verification test for A2L refrigerants

NN.1 General

Annex NN is applicable to appliances using **A2L refrigerants**. 122

A flame arrest enclosure is a device or assembly enclosing components with electrical contacts that are made and broken, or similar devices which ~~may can~~ become a source of ignition which will withstand an internal ignition of a **A2L refrigerant** vapour which ~~may 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.

~~The following test requirements are based on consideration of IEC 60079-15:2010, Clause 17, as applicable to the products within the scope of IEC 60335-2-40, and specific to the use of flammable A2L refrigerants.~~

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 per 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 s ± 0,05 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 per 16.3 shall be conducted after the test.*

NN.2.9 *The enclosure shall be considered in compliance with this annex 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.*

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Annex OO

(Void)

(normative)

UV-radiation conditioning 123

~~OO.1 Ten samples of the internal wiring are subjected to ultraviolet light conditioning according to Clause OO.2 or OO.3. When the internal wiring is provided in more than one colour, ten samples of each colour are subjected to this conditioning.~~

~~The test samples are mounted on the inside of the cylinder in the ultraviolet light apparatus perpendicular to the light source and in such a way that the samples do not touch each other.~~

~~OO.2 The samples are to be exposed for 1 000 h to xenon arc, method A, in accordance with ISO 4892-2. There shall be continuous exposure to light and intermittent exposure to water spray. The cycle shall consist of 102 min without water spray and 18 min with water spray. The apparatus shall operate with a water-cooled xenon arc lamp, borosilicate glass inner and outer optical filters, a spectral irradiance of 0,35 W/m²/nm at 340 nm and a black panel temperature of (65 ± 3) °C. The temperature of the chamber shall be (45 ± 3) °C. The relative humidity in the chamber shall be (50 ± 5) %.~~

~~OO.3 The samples are to be exposed for 720 h to open flame carbon arc, in accordance with ISO 4892-4. There shall be continuous exposure to light and intermittent exposure to water spray. The cycle shall consist of 102 min without water spray and 18 min with water spray. The apparatus shall operate with an open flame carbon arc lamp, borosilicate glass Type 1 inner and outer optical filters, a spectral irradiance of 0,35 W/m²/nm at 340 nm and a black panel temperature of (63 ± 3) °C. The temperature of the chamber shall be (45 ± 3) °C. The relative humidity in the chamber shall be (50 ± 5) %.~~

Annex PP (normative)

Leak detection system confirmation test for flammable refrigerants

PP.1 General 124

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 seconds 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 seconds 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 seconds 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 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 this annex, 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 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 per 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:

$$A_t = 2,4 \times \dot{m}_{\text{leak}} / (LFL \times h_t) \quad (\text{PP.1})$$

where

A_t is the minimum room area for the test in m²;

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/m³;

2,4 is the conversion factor based on limiting the test room concentration to 5 % of **LFL** at the end of a 120 seconds 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:

$$\dot{m}_{\text{leak}} = 4 \times LFL \quad (\text{PP.2})$$

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 minute leak of m_c and converting 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 is **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: **125**

$$\dot{m}_{\text{leak}} = \left[\frac{Q h_o^{1/4} [LFL \times (1 - CF)]^{5/8}}{3\,600 \times 5Y \sqrt{A_o}} \right]^{4/3} \quad (\text{PP.4})$$

where

Q is the unit 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 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/m³;

CF is a concentration factor as selected for GG.14.3.1.

PP.2.2.3.3 Enhanced tightness refrigerating systems

For non-enhanced tightness refrigerating systems with A2L refrigerants the leak rate shall be maintained at:

$$\dot{m}_{\text{leak}} = CF \times LFL \times Q \times 1\,000/3\,600, \text{ but not less than } 4 \times LFL \quad (\text{PP.5})$$

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/m³;

Q is the unit airflow volume in m³/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:

$$\dot{m}_{\text{leak}} = \frac{1\,000 \times Q \, m_c^{1/4} \, LFL^{3/4}}{3\,600 \times 8Y \sqrt{A_o}} \left(\frac{1 - CF}{CF^{1/4}} \right) \quad (\text{PP.6})$$

where

$\dot{m}_{\text{leak}}$ is the refrigerant leak rate in g/s;

Q is the unit airflow volume in m³/h;

1 000 is a constant to convert kg to g;

3 600 is a constant to convert m³/s to m³/h;

8 is a constant;

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;

m_c is the actual **refrigerant charge** amount in the system in kg;

LFL is the **lower flammability limit** in kg/m³;

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. **126**

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:*

$$A_o = 4 \times LFL / 1,7 \quad (\text{PP.7})$$

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 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.

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.

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Annex QQ (normative)

Methods for determining releasable charge

QQ.1 General 127

The **releasable charge** m_{rl} shall be determined in each **operating state** in accordance to this annex.

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, QQ.3, or QQ.4. 128

NOTE 3 The **releasable charge** can be determined by calculation, measurement or a combination, 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 3 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 minutes 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 3 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 minutes 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 hours, 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:*

$$m_{rl} = m_c - m_{ret} \quad (QQ.1)$$

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 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 minutes, 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 3 times and the **releasable charge** shall be 2 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 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 leak is detected as determined in Clause QQ.5 in s;

m_{r2} is the charge released between detection and closing the shut-off valves as determined in QQ.4.2 in kg;

m_{r3} is the refrigerant released after closing the 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 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 m^3 ;

$\rho_{part,i}$ is the apparent density of in the evaluated part i in kg/m^3 .

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 minutes.*

For the test in standby mode, the system shall be stopped for 8 hours after the cooling operation according to the condition specified in Clause QQ.6 for 30 minutes.

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 minutes 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 minutes, and then stopped for 8 hours.

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 3 times and the measured refrigerant amount, m_{rm} , shall be 2 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} 129

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 Clause LL.3. 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:

$$t_{r1} = (H_r \times A_{min} \times LFL \times C_{set} / 0,002\ 8) + 30 \quad (QQ.7)$$

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 Clause LL.3.

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: **130**

- 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 60079-15:2010, *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 22712⁴, *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*

⁴ Under preparation. Stage at the time of publication: ISO FDIS 22712:2022

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

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

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List of comments

- 1 The CDV of IEC 60335-2-40 ed7.0 was issued before the publication of IEC 60335-1 ed6.0. Therefore IEC 60335-2-40 ed7.0 is to be used in conjunction with edition 5.2 of IEC 60335-1.
- 2 Scope is expanded to cover thermoelectric dehumidifiers and heat pumps as these have been lacking an appliance standard.
- 3 Voltage for single phase applications are increased to match voltage used in the US.
- 4 Wording is added to highlight that the competence of personnel is not covered by this standard. With the increasing use of flammable refrigerants in the market, the competence of personnel is increasingly important for the safe installation, servicing, and disposal of appliances.
- 5 To clarify that a typical water cooler is considered a fixed appliance.
- 6 Particle foam materials are used in the market to provide structural support along with thermal, sound, and electrical insulation. Requirements for these materials are added to ensure the proper application.
- 7 Additional definitions for types of supplementary heaters are added to clarify wording in the standard.
- 8 To clarify that the maximum allowable pressure is always specified by the manufacturer.
- 9 Wording is aligned throughout the standard.
- 10 The term “potential ignition source” is clear from the context where it is used, and a definition therefore is not needed.
- 11 The number of terms related to ultraviolet radiation are reduced, since the usage is limited in the standard. Most of the deleted definitions are only used in other definitions.
- 12 The releasable charge concept is new to this 7th edition. The philosophy is that only refrigerant leaking to the occupied space will create a hazard.
- 13 The concept of operating state is used to ensure that all modes of operation are covered in various tests. In addition, different operating states may apply different mitigation measures to ensure that the appliance is safe.
- 14 These systems are actively limiting the amount of refrigerant leaked to the indoor space.
- 15 This term is introduced as an umbrella definition covering all ways of detecting a leak, including refrigerant detectors.
- 16 This term is introduced to align wording throughout the standard on where a leak can occur.
- 17 Not all appliance installation instructions allow pipe length to be between 5 m and 7,5 m. The text clarifies how to handle these cases.
- 18 Motor compressors are handled in 19.7 and 24.1 and therefore are no longer mentioned in Clause 5.
- 19 Wording of 7.1 is rearranged to improve readability.
- 20 Pre-charged pipe sets require the same warning signs as appliances with flammable refrigerant.

- 21 A new combined symbol is introduced, namely the flame symbol combined with the refrigerant safety group. This is both on the appliance (at least 30 mm), near the refrigerant designation marked on the unit (at least 10 mm), near service ports and on the packaging of pre-charged systems (at least 30 mm). For smaller units it is possible for a single occurrence of this marking to cover all three purposes.
- 22 A new symbol is used for indicating the minimum room area. This symbol was first introduced in IEC 60335-2-89.
- 23 The minimum and maximum air temperatures is a part of the operating envelope of the appliance.
- 24 Requirements for marking on appliance on display for sale are deleted, since this is outside the scope of this standard.
- 25 Wording is added to clarify requirements previously only stated in Figure 102.
- 26 Text is modified to focus on the intention that thermocouples should be small enough not to influence the measuring result. The previous text could be read as requiring thermocouples to have diameter not exceeding 0,3 mm, and for large appliances such small thermocouples can be too fragile to be practical.
- 27 The maximum air temperature is increased from 90 °C to align with national requirements in the US.
- 28 Generalisation of requirements previously in 11.2.
- 29 The appliances in this standard are generally not operating at ambient temperatures, and the maximum temperatures therefore need to be relative to 25 °C. E.g. an air-conditioner operating at 60 °C cannot be allowed surfaces to be 35 K higher than the maximum surface temperature allowed when operating at 25 °C air temperatures.
- 30 Table is changed from giving maximum temperatures in °C and replacing Table 3 in IEC 60335-1 to being an addition applying temperature rise in K.
- 31 A maximum leakage current of 3,5 mA is allowed for small stationary class I motor-operated appliances.
- 32 To align with 13.2, a maximum leakage current of 3,5 mA is allowed for small stationary class I motor-operated appliances.
- 33 19.2 changed from replacement to addition to align with IEC 60335-1. Requirements for appliances with supplementary air heaters are in 19.104.
- 34 19.3 changed from replacement to addition to align with IEC 60335-1. Requirements for appliances with supplementary air heaters are in 19.104.
- 35 Running overload test is relevant except for selected components:
- motor compressors because they are covered elsewhere in this standard,
 - circulation pumps when they comply with the relevant part of IEC 60335,
 - fans because the standard for fans, IEC 60335-2-80, does not require a running overload test. HVAC fans are not in the scope of IEC 60335-2-80.
- 36 “Engineering judgement” is too non-descriptive, and in most situations will be allowed without an explicit statement.
- 37 Additional temperatures in Table 9 are to avoid fire from ducted products with additional heaters. These requirements were previously in the text of 19.104.
- 38 Additional tests are added for appliances with supplementary air heaters.

- 39 Piping can be flexible and cannot always ensure adequate stability.
- 40 To clarify the relevant subclause in ISO 5149-2, and remove overlap between Annex EE and ISO 5149-2.
- 41 Particle foam material is less resistant to sharp objects, and the test is therefore also to be done on thicker parts of particle foam.
- 42 Test is rewritten to reference an ISO standard instead of ASTM D4728. The technical requirements are unchanged.
- 43 For very large appliances, vibration tables are not available, therefore an alternative test description is added.
- 44 The text on alternative methods was too non-descriptive.
- 45 To clarify which subclauses of ISO 5149-2 are applicable.
- 46 As it is unlikely that more than one refrigerating circuit leaks at a time, the upper limit to the sum of charges is removed.
- 47 This sets the upper charge limit for all flammable refrigerants under this standard.
- 48 22.116 is restructured for better readability.
- 49 Some of the tests in IEC 60079 are excluded since they cover the same concerns as similar tests in IEC 60335-1. The tests in IEC 60335-1 are easier to pass since the requirements in IEC 60079 cover a tougher operating environment than what is intended for appliances under IEC 60335-1 and IEC 60335-2-40.
- 50 22.116.3 is a new test. The philosophy being that a component is not an ignition source if it is tight enough to keep a flammable atmosphere out for the duration of a leak.
- 51 22.116.4 is a modification of the test for switched inductive loads. To match the original supporting data for the method, it has been limited to only cover A/C currents with upper limits on the power factor and on breaking current.
- 52 To align with IEC 60079 series and ISO 5149-2:2014, 5.2.12.
- 53 700 °C limit is removed as test according to Annex KK is enough to prove there will be no ignition.
- 54 For some refrigerant sensor technologies the surface temperatures will be above the auto-ignition temperature, and LL.11 "Ignition test" ensures that these refrigerant sensors cannot ignite leaked refrigerant.
- 55 It is unlikely that a malfunction leading to higher temperatures will occur at the same time as a leak. Therefore only normal operation is relevant.
- 56 The sensor position is verified in the applicable annexes, stagnation of leaked refrigerant is just one factor.
- 57 If a leak can occur without causing a hazard, then a refrigerant detector is not needed.
- 58 The releasable charge determination in Annex QQ includes verification of the leak detection system for the purpose of determining releasable charge.
- 59 Due to the higher flammability the refrigerant sensor is required to be factory mounted. This limits the type of joints made on site.
- 60 22.122 links Annex LL to the rest of the standard, including Annex GG.
- 61 22.123 is rewritten for clarity.

- 62 Requirements are covered in 22.121 and 22.122.
- 63 Requirements are rewritten to reference ISO standards instead of UL and CAN/CSA standards.
- 64 Power failure is not considered normal operation.
- 65 The intention is to allow the system to resume after a false leak detection. A false leak detection needs to bring the system into a safe mode, but not disturb the end-user enough to make the end-user override the leak detection system.
- 66 This is similar to refrigerant detectors, which are also factory fitted for A2/A3 refrigerants.
- 67 The intention is to limit the combined leak through all safety shut-off valves leading to an indoor unit to a level too low to cause a hazard.
- 68 Some types of valves will be tighter at higher pressures, while others will be tighter at lower pressures.
- 69 The concern is that the general public, especially children playing, can damage particle foam materials used as electrical insulation.
- 70 Degradation of wiring due to UV radiation is covered in IEC 60335-1.
- 71 To clarify requirements for motor-compressors.
- 72 Plugs are not considered suitable for permanent outdoor use.
- 73 Particle foam materials generally fail the test of 30.1. The alternative test added in 30.101 has been verified for EPP and EPS only.
- 74 Clarification is based on the previous text in the NOTE and the footnote in Table 102.
- 75 Additional refrigerants are added and burning velocities are added where available to support the application of 22.116.
- 76 To align with the change to 22.117.
- 77 Requirement for not relying on formula is moved up to highlight the importance of this requirement for all aspects of working with the system in the field.
- 78 Table is corrected: Refrigerant removal is not relevant for installation and decommissioning procedures are only relevant for decommissioning.
- 79 List is restructured for readability and expanded.
- 80 Repairing Ex approved components require a competence level beyond what is expected for service technicians repairing appliances under this standard.
- 81 Test is rewritten to improve clarity.
- 82 Heating refrigerant bottles or compressors with an open flame is a dangerous practice sometimes observed in the field.
- 83 Annex EE is restructured. The philosophy is that the maximum allowable pressure is defined by the manufacturer and marked on the system, and Annex EE is verifying that this pressure will not be exceeded.
Strength and fatigue tests are added to align with ISO 5149-2. These tests ensure that the system is capable to withstand the maximum allowable pressure.
- 84 Rewritten to improve clarity.

- 85 The leak rate for testing enhanced tightness refrigerating systems is modified to match the lower leak rates assumed throughout this standard for these systems.
- 86 FF.2.2 is rewritten to improve clarity.
- 87 It is considered unlikely that more than one refrigerating system leaks at the same time.
- 88 This allows the system designer to choose the most relevant charge limit clause of Annex GG.
- 89 To clarify which topic of ISO 5149-1 is relevant.
- 90 This allows for the releasable charge to be applied to most charge limit methods. It is not applicable to GG.4 ventilated enclosures, since these are already allowed a charge limit of m3, and it is not applicable to GG.10, since GG.10 builds on a philosophy of risk reduction the releasable charge cannot simply be inserted instead of the actual charge.
- 91 GG.1.3.3 is a new subclause clarifying when two rooms are connected enough to be considered a single space for the purpose of determining charge limits for A2 and A3 refrigerants.
- 92 This introduces an upper limit for A2 and A3 refrigerants in very small rooms.
- 93 Requirements for circulation airflow operation is aligned throughout Annex GG.
- 94 The airflow equation in GG.2.3 builds on jet theory. The intention is to have a large leak, defined as the refrigerant charge leaking during 4 minutes, being diluted before the air jet travels across the room.
- 95 The required ventilation rate is modified for enhanced tightness systems to take the lower leak rate into account.
- 96 To clarify which clauses and subclauses of ISO 5149-3 are relevant.
- 97 Vibration requirements are updated and the reference to ASTM D4728 removed.
- 98 Natural ventilation to an indoor space is covered by GG.1.3.2, and therefore deleted in GG.8. Natural ventilation to the outdoors is rewritten for improving readability.
- 99 The required size of the room being ventilated to is modified to only take the additional charge into account.
- 100 This requirement was previously only in DD.3.1 as a requirement in the manuals.
- 101 GG.10 is restructured for readability and charge limits are increased.
- 102 GG.11 is restructured for readability and the ambiguous reference to GG.10.4 removed.
- 103 GG.12 is rewritten to allow higher charge limits and to take into account that Annex QQ is added with methods for determining the releasable charge.
- 104 GG.14 contains two methods for determining the charge limit for enhanced tightness refrigerating systems using A2/A3 refrigerants.
- 105 The upper limit of 0,35 is determined based on a series of leakage tests.
- 106 The airflow equation in GG.14.3 builds on jet theory. The intention is to have a leak being diluted before the air jet travels across the room.
- 107 The leak mass flow rate for an enhanced tightness refrigerating system is determined as the flow through a hole the size of which would give a leak rate of 10 kg/h R-32.

- 108 Annex JJ test requirements are based on consideration of IEC 60079-15:2010, Clause 17, as applicable to the products within the scope of IEC 60335-2-40, and specific to the use of flammable A2L refrigerants.
- 109 Annex LL is rewritten and expanded to be almost a complete refrigerant detector standard. The references to other annexes and the main body of the standard is kept to a minimum to make it possible for the annex to become an independent IEC 60335 part, if this is requested at a later point in time.
- 110 The intention is to allow refrigerant sensors which can only detect a leak a limited number of times, and if exposed to very high concentrations can only detect refrigerant once. But when such a sensor is “used up” it needs keep giving an output indicating a leak, while giving a signal for replacement.
- 111 Service technicians are not expected to have sufficient competence to ensure an accurate calibration in the field.
- 112 Test gases are based on the list in the 2nd edition of UL 2075. However testing with trichloroethane is found irrelevant, as this substance is restricted under the Montreal Protocol. Hexamethyldisiloxane is added to the list since siloxanes are used in cosmetics.
- 113 LL.6 is based on the AHRTI Project 9014: Refrigerant Detector Characteristics for Use in HVACR Equipment.
- 114 LL.8 is based on EN 50194-1:2009, 5.3.8.1.
- 115 LL.9 is inspired by IEC 60079-29-1:2016, 5.4.6.
- 116 LL.10 is based on 60079-29-1:2016, 5.4.12.2.2.
- 117 This implies that the sensor can be tested as part of the equipment.
- 118 LL.11 is inspired by EN 50194-1:2009, 5.3.15.
- 119 LL.12 is inspired by IEC 60079-29-1:2016, 4.2.9.6.
- 120 The intention is to have sufficient information to allow service technicians to replace the sensor with an equivalent device.
- 121 MM.2 is rewritten to take into account that it is irrelevant to test so high air flows that a leak will not create a hazard.
- 122 Annex NN test requirements are based on consideration of IEC 60079-15:2010, Clause 17, as applicable to the products within the scope of IEC 60335-2-40, and specific to the use of flammable A2L refrigerants.
- 123 The effect of UV radiation on wiring is covered by IEC 60335-1.
- 124 Annex PP is a new annex for verification of leak detection systems. The concept is to measure the time from the start of a leak to mitigation measures being active. This allows for leak detection being based on other principles than refrigerant detectors.
For refrigerant detectors the time required to detect a leak depends on the location of the refrigerant detector, and this annex can therefore not be applied to remote refrigerant sensors.
- 125 The leak rate is based on Equation GG.43 in GG.14.3.
- 126 The low leak rate is based on Equation GG.15 in GG.2.3.1.

127 Annex QQ has three methods for determining releasable charge:

- QQ.2 is applying a simulated leak to the atmosphere
- QQ.3 is applying a simulated leak to a volume at atmospheric pressure. The intention is to avoid releasing large amount of refrigerant to the atmosphere during the test. This test method relies on estimating the reaction time of the leak detection system
- QQ.4 is a mixed method approach, where the maximum charge in each part of the refrigerating system is determined by calculation or test, and the summing up of the charge available to be released should a leak occur. This test method also relies on estimating the reaction time of the leak detection system

128 Both QQ.3 and QQ.4 assume an enhanced tightness system.

129 Estimation of reaction time from leak to refrigerant sensor output is used by QQ.3 and QQ.4.

130 Test conditions are aligned with PP.3.4.

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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 Void	29
13 Leakage current and electric strength at operating temperature	29
14 Transient overvoltages	29
15 Moisture resistance	29
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	39
23 Internal wiring	51
24 Components	51
25 Supply connection and external flexible cords	52
26 Terminals for external conductors	53
27 Provision for earthing	53
28 Screws and connections	53
29 Clearances, creepage distances and solid insulation	53
30 Resistance to heat and fire	53
31 Resistance to rusting	55
32 Radiation, toxicity and similar hazards	55
Annexes	62
Annex D (normative) Thermal motor protectors	62
Annex I (normative) Motors having basic insulation that is inadequate for the rated voltage of the appliance	62
Annex AA (informative) Examples for operating temperatures of the appliance	63
Annex BB (normative) Selected information about refrigerants	64
Annex CC (informative) Transportation, marking and storage for units that employ flammable refrigerants	68

Annex DD (normative) Requirements for installation, service, maintenance and repair, and decommissioning manuals of appliances using flammable refrigerants	69
Annex EE (normative) Pressure tests	78
Annex FF (normative) Leak simulation tests	80
Annex GG (normative) Charge limits, ventilation requirements and requirements for secondary circuits	82
Annex HH (informative) Competence of service personnel	115
Annex II (Void)	117
Annex JJ (normative) Allowable openings of relays and similar components to prevent ignition of A2L refrigerants	118
Annex KK (normative) Test method for hot surface ignition temperature for A2L	120
Annex LL (normative) Refrigerant detection systems for flammable refrigerants	124
Annex MM (normative) Refrigerant sensor location confirmation test	135
Annex NN (normative) Flame arrest enclosure verification test for A2L refrigerants	138
Annex OO (Void)	140
Annex PP (normative) Leak detection system confirmation test for flammable refrigerants	141
Annex QQ (normative) Methods for determining releasable charge	147
Bibliography	155
Figure 101 – Example of label for field charged units	57
Figure 102 – Arrangement for heating test of appliances with supplementary air heater	59
Figure 103 – Supply circuit for locked-rotor test of a motor of the single-phase type – Revise as needed for three-phase test	60
Figure 104 – Power spectral density profile for vibration test in 21.101	60
Figure 105 – Dimensional details for the weight in the area of the pressure ball	60
Figure 106 – Measurement before and after the test	61
Figure GG.1 – Unventilated area	112
Figure GG.2 – Mechanical ventilation	112
Figure GG.3 – Relevant heights h_{inst} , h_0 and h_{rel} for calculation of A_{min} and m_{max}	113
Figure GG.4 – Airflow direction	114
Figure KK.1 – Front view of test apparatus labels	120
Figure KK.2 – Test apparatus with dimensions	121
Figure KK.3 – Top view of test apparatus	122
Figure LL.1 – Example of test chamber design	130
Table 101 – Power spectral density profile for vibration test	38
Table 102 – UVC spectral irradiance measurement location	56
Table AA.1 – Examples for operating temperatures of the appliance	63
Table BB.1 – Selected information about refrigerants	64
Table DD.1 – Mandatory clauses in each manual	69
Table GG.1 – Outline of Annex GG (informative)	83
Table GG.2 – Circulation airflow	88
Table GG.3 – Appliance with packaging	95

Table GG.4 – Appliance without packaging	95
Table GG.5 – Minimum air velocity	107
Table GG.6 – Refrigerant leak rate ($\dot{m}_{\text{leak}}$).....	110
Table LL.1 – Relationship among alarm set point, tolerance and test gas (informative)	126
Table LL.2 – Gas and vapour concentrations	128
Table LL.3 – Example of the test chamber design	131

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

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

FOREWORD

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IEC 60335 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 seventh edition cancels and replaces the sixth edition published in 2018. This edition constitutes a technical revision.

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

- Clause 1 – added **thermoelectric heat pumps** to the scope and increased maximum **rated voltage** to 300 V for single phase appliances;
- Clause 7 – revised requirements for marking on the appliance and packaging, including a symbol for minimum floor area and modifying the symbol for **flammable refrigerants** to include the safety group per ISO 817;
- Clause 11 and Clause 19 – restructured for alignment with Part 1 and added requirements for **supplementary air heaters**;

- Clause 13 and Clause 16 – revised requirement for leakage current for **stationary class I motor-operated appliances**;
- Clause 21 – added requirements for **particle foam material** and revised requirements for transport testing;
- Clause 22 – removed limit on the sum of **refrigerant charges** for appliances with multiple **refrigerating systems**, and revised requirements for avoiding ignition sources, **leak detection systems**, **safety shut-off valves**, and **particle foam material**;
- Clause 23 – added requirements to avoid contact between wires and refrigerant piping;
- Clause 24 – revised requirements for motor-compressors;
- Clause 30 – added requirements for resistance to heat of **particle foam material**;
- Annex BB – revised Table BB.1 with refrigerant information and added a link to ISO 817 refrigerant data;
- Annex DD – revised requirements for information in the manual for appliances with **flammable refrigerants**;
- Annex EE – revised requirements for pressure testing;
- Annex FF – revised requirements for leak simulation tests;
- Annex GG – added requirements for applying **releasable charge**, added additional coverage for A2 and A3 refrigerants, including new charge limits for appliances with **circulation airflow** and for **enhanced tightness refrigerating systems**, and revised requirements for **enhanced tightness refrigerating systems** using **A2L refrigerant**;
- Annex LL – revised requirements for **refrigerant detection systems**;
- Annex MM – revised simulated leak rate;
- Annex OO – deleted annex for conditioning internal wiring using UV light.
- Annex PP – new coverage of **leak detection system** confirmation test;
- Annex QQ – new coverage of method for determining **releasable charge**.

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

Draft	Report on voting
61D/491/FDIS	61D/493/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.

This part 2-40 is to be used in conjunction with IEC 60335-1:2010, its Amendment 1:2013 and its Amendment 2:2016.

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: Safety 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 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).

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.

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

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

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

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.

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 multi-phase 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 laymen 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 prescribe 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 persons. Criteria for competence of personnel for the purpose of certification schemes can be found in ISO 22712¹.

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.

¹ Under preparation. Stage at the time of publication: ISO FDIS 22712:2022

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.

NOTE 105 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 60079-14:2013, *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*

ISO 817, *Refrigerants – Designation and safety classification*

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

ISO 1302:2002², *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 5151:2017, *Non-ducted air conditioners and heat pumps – Testing and rating for performance*

ISO 5151:2017/AMD1:2020

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 13355:2016, *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.

² Withdrawn.

3.1.9 *Replacement:*

normal operation

conditions that apply when the appliance is mounted or installed as in normal use and is operating under the most severe operating conditions specified by the manufacturer

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**.

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 may 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 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

the 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 may 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 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** may 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, definition 3.7.7, modified – "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 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 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 may 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.

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 Clauses 11, 19 and 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 tests of Annex LL are carried out, additional **refrigerant sensors** are needed.*

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 Subclauses 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 Clauses 10 and 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 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 the symbol need not 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.

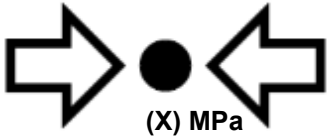
If not already visible when accessing a **service port** and if a **service port** is provided, the **service port** shall be marked to identify the type of refrigerant. If the refrigerant is flammable, symbol ISO 7010-W021 (2011-05) including the safety group per ISO 817 shall be included, without specifying 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 the appliance shall be installed in accordance with national wiring regulations;
- 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 which shall state that the vent shall not be obstructed.

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**, an installation manual, service, maintenance and repair manual, and decommissioning manual, either as separate or combined manuals, 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 assure 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 may, 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.

8.1.5 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 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 Figure 102b, rotated 90 degrees 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 1 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 2 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 Test casing

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 and NOTE 1 with:

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.

11.3 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 this 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 (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 Void

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 may 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 11.6, and the tests of Clause 16.

*Following these tests, an inspection is made within the enclosures. The water which may 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 test

*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 60335-2-40, 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 IEC 60335-1, 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.*

*Components 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 need not 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 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 note:

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 may 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** 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 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 Subclause 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 Clause 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 hours, 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.

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.

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, Subclause 4.4.2.

The pressure test in Annex EE applies to parts other than **pressure vessels**.

21.2 Modification:

Add the following sentence after 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 13355:2016 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 13355:2016 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.

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.

22.46 Modification:

Add the following after the 1st paragraph:

If the **protective electronic circuit** software is a part of the **normal operation** control, inspection of software shall be limited to relevant source code of safety controls or related software controls.

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 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 **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.

22.112 The construction of the **refrigerating system** shall comply with the requirements of ISO 5149-2:2014, Subclauses 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 and ISO 5149-2:2014/AMD1:2020, Subclauses 4.1, 5.2.3, 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 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, Clauses 7 through 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 Clause LL.11.*

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 incandive 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/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 per 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 48A 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 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 Clauses 11 and 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 Clause LL.11 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 source 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 assure 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 level 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 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, the **refrigerant sensor** may be 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 located

- 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 mechanical joints shall not require that **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 need 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 Clauses QQ.3 and 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 fulfil 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** provides notification to the user that replacement of the **refrigerant sensor** is required, then resetting this notification shall only be possible when the **refrigerant sensor** has been replaced.

Refrigerant detection system shall comply with Annex LL.

Compliance is checked by inspection and tests according to Annex LL.

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 ISO 13256.*
- *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-percent 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 Subclause 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 $1,7 \mu\text{W}/\text{cm}^2$, 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 Subclause 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 Subclause 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

Safety shut-off valves 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 hours.

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 below test, 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 minute:

- $0,02 \times$ **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.

NOTE 5 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 6 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 second 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.

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
- electromechanical proof of airflow control 100 000
- self-resetting electrical **pressure-limiting device** 3 000
- non-self-resetting electrical **pressure-limiting device** 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 2A or 2B;
- shall have a trip free mechanism of type 2J;
- 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/m^3 and less than or equal to 250 kg/m^3 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 ($\pm 2 \text{ °C}$) 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 2 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 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

This clause of Part 1 is applicable except as follows.

32.101 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 µW/cm².

NOTE The **UV-C spectral irradiance** limit of 0,2 µW/cm² is equivalent to 0,1 µW/cm² effective irradiance at 254 nm (i.e., 0,2 µW/cm² multiplied by the hazard function, $S_{UV} = 0,5$ at 254 nm as defined in IEC 62471 equals 0,1 µW/cm²). Effective irradiance of 0,1 µW/cm² 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 µW/cm². 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 µW/cm² **spectral irradiance**, that the user would experience in performing his duties.

NOTE The **UV-C spectral irradiance** limit of 1,7 µW/cm² is equivalent to 0,85 µW/cm² effective irradiance at 254 nm (i.e., 1,7 µW/cm² multiplied by the hazard function, $S_{UV} = 0,5$ at 254 nm as defined in IEC 62471 equals 0,85 µW/cm²).

*Compliance is determined by measuring the **UV-C spectral irradiance** per IEC 62471:2006, Clause 5 and Annex B.*

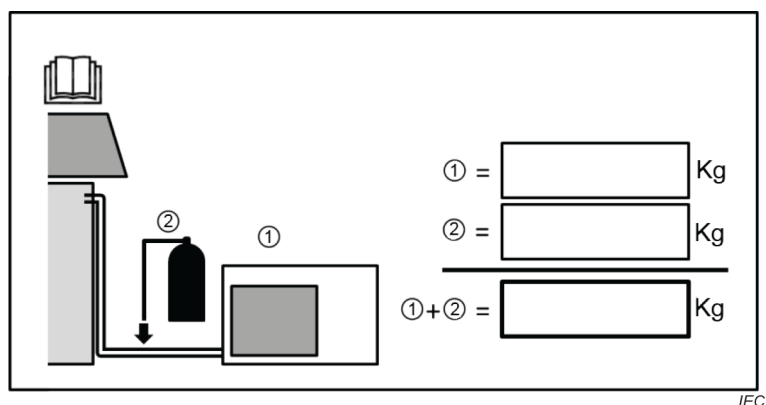
32.101.3 **UV-C spectral irradiance** shall be measured at the location indicated in Table 102.

Table 102 – UVC 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 per 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.

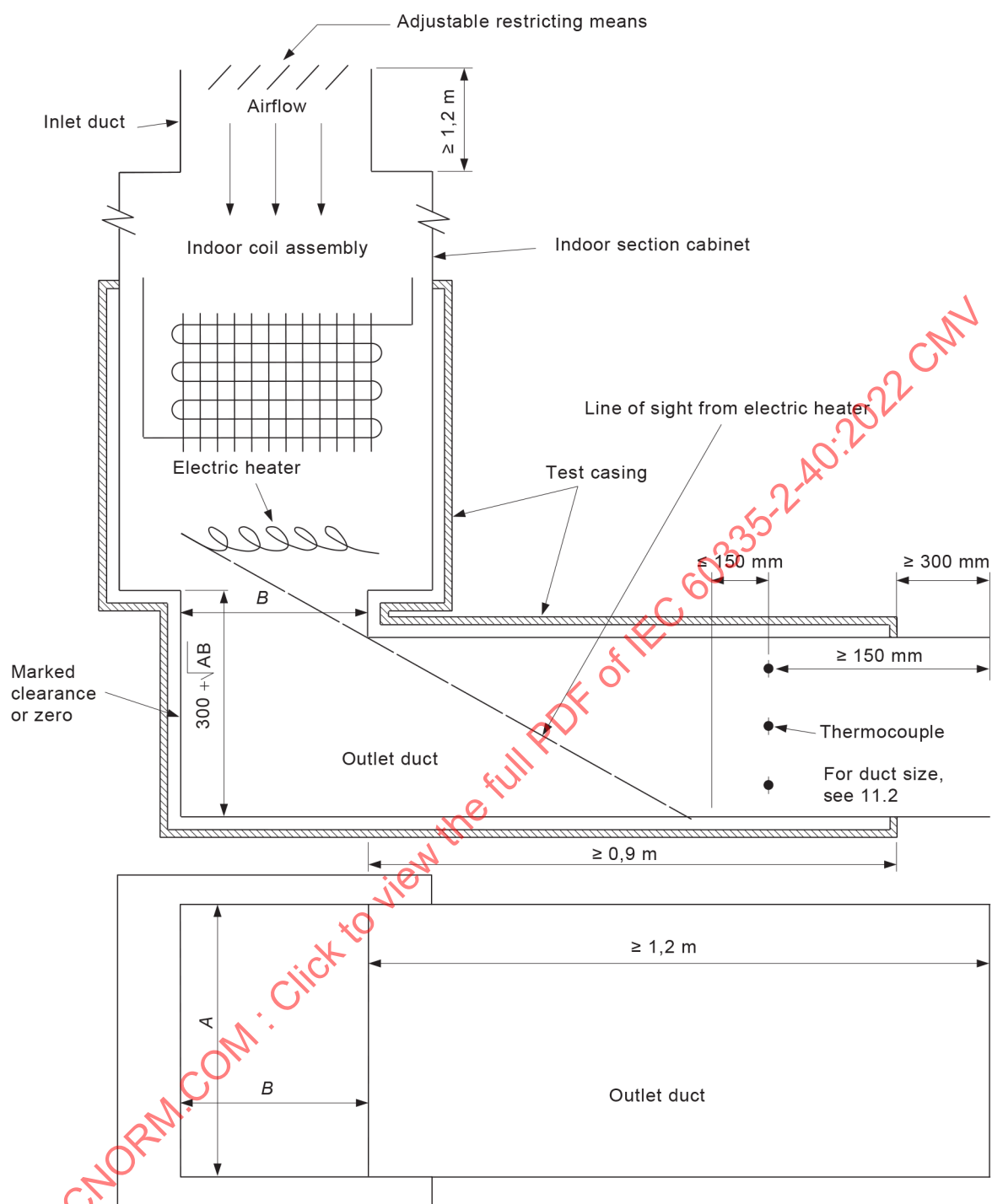
**Key**

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

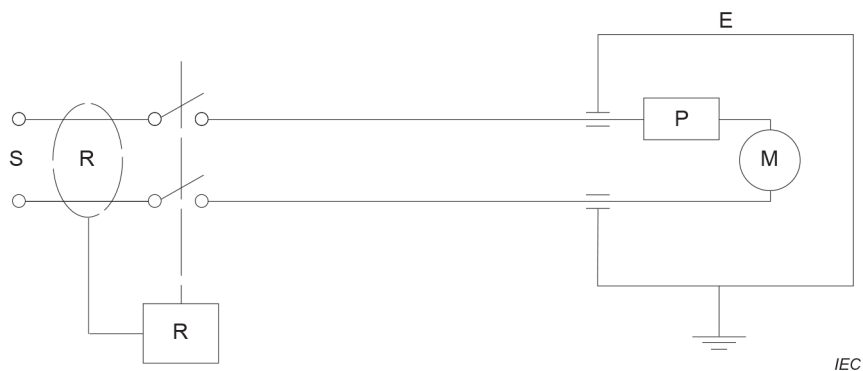
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b) Downflow application

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

Figure 103 – Supply circuit for locked-rotor test of a motor of the single-phase type – Revise as needed for three-phase test



Figure 104 – Power spectral density profile for vibration test in 21.101

Dimensions in millimetres

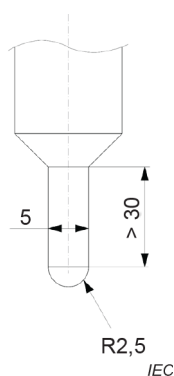
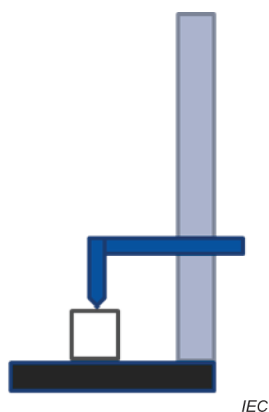
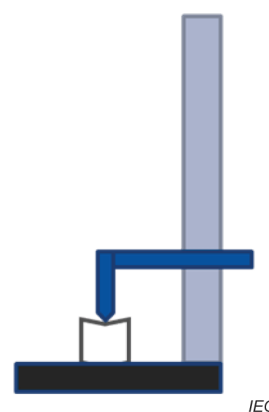


Figure 105 – Dimensional details for the weight in the area of the pressure ball



Measurement 1: Height specimen unloaded



Measurement 2: Height specimen after loading

Figure 106 – Measurement before and after the test

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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.

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Annex AA

(informative)

Examples for operating temperatures of the appliance

Table AA.1 gives examples for operating temperatures of the appliance.

Table AA.1 – Examples for operating temperatures of the appliance

[illegible]

Annex BB (normative)

Selected information about refrigerants

Table BB.1 gives selected information about refrigerants.

Table BB.1 – Selected information about refrigerants

NOTE This annex 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 g	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, $S_{u,i}$ at 23 °C relative humidity at nominal composition	Burning velocity, $S_{u,i}$ 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	0,307	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) ₃	A3	460	NA	460	2,37	58,1	NA	0,043	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 n	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
R1150	Ethylene	CH ₂ =CH ₂	A3	425	NA	ND	1,15	28,1	NA	0,036	NA		
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		

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
				°C	°C (A2L only)	°C	kg/m ³	kg/kmol	kg/kmol	kg/m ³	kg/m ³	cm/s	cm/s
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		
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	< 1,5	
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		
R-465A	R-32/290/1234yf	(21,0/7,9/71,1)	A2L	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 http://standards.iso.org/iso/817/led-3/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/m ³ .
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 need to 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 manuals of appliances using flammable refrigerants

DD.1 General

Each manual shall include requirements of clauses according to Table DD.1. Different manuals can be combined into one manual.

Numerical values needed 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**, the installation manual does not need to include material from DD.4.8 and Clause DD.9.

Table DD.1 – Mandatory clauses in each manual

Clause	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 manual 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.5.1	No	Yes	No	
DD.5.2	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 manual

DD.3.1 General

The following information shall be specified in the manual where the information is needed for the function of the manual 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 compliance with national gas regulations shall be observed;
 - 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_{rl} . **Safety shut-off valve** location and refrigerant piping volume between **safety shut-off valve** and the indoor unit shall be taken into consideration;

NOTE Additional requirements for field-testing are in DD.3.1, item 26).

- 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** 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** GG.11.3.3;
- 12) for appliances relying on safety measures according to GG.8.3 or for **enhanced tightness refrigerating systems** 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 may 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 manual 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 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 manual 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 manual 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 to 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 aging 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 need 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 following local and national regulations;
- 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 venting 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 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 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 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) 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 de-commissioned 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 according to local legislation in the correct recovery cylinder, and the relevant waste transfer note arranged. 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.

A compressor tested and found to comply with IEC 60335-2-34 need not be additionally tested.

Compliance is checked by the tests in Clause EE.3 or 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.*

Pressure gauges and control mechanisms need not 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 be not 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 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 hour 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 seconds 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 installation space of 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**. 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 WCF – Worst Case Formulation as specified in Annex BB.

Toxicity charge limits shall be determined per 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 clauses: GG.2, GG.3, GG.4, GG.7, GG.9, and GG.14. The **refrigerant charge** m_c may 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. Determine the column for indoor or outdoor application. 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** are permitted for each range in Table GG.1.

Table GG.1 – Outline of Annex GG (informative)

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 $m_{r1} \leq m_1$	No room size restriction			No room size restriction	No room size restriction, GG.6
$m_1 < m_c \leq 2 \times m_1$ (appliances which are not fixed appliances)	Not allowed	GG.7	Not allowed		
$m_1 < m_c \leq m_2$	GG.2.1	GG.2.2 ^c , GG.2.3 ^d , GG.9 ^c , GG.10 ^c , GG.14 ^d	GG.3, GG.8 ^c , GG.10 ^c		
$m_2 < m_c \leq m_3$	Not allowed	GG.9 ^c , GG.10 ^c	GG.3, GG.8 ^c , 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:

$$m_1 = 4 \times LFL \quad (\text{GG.1})$$

$$m_2 = 26 \times LFL \quad (\text{GG.2})$$

$$m_3 = 130 \times LFL \quad (\text{GG.3})$$

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:

$$m_1 = 6 \times LFL \quad (\text{GG.4})$$

$$m_2 = 52 \times LFL \quad (\text{GG.5})$$

$$m_3 = 260 \times LFL \quad (\text{GG.6})$$

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/s²;
- 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** $m_1 < m_c \leq m_2$ 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 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 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 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:

$$m_{\max} = CF \times LFL \times h_{ra} \times A \quad (\text{GG.10})$$

or the required minimum room area $A_{\min}$ of installed appliance with **refrigerant charge** m_c (kg) shall be in accordance with following:

$$A_{\min} = m_c / (CF \times LFL \times h_{ra}) \quad (\text{GG.11})$$

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 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.				

$$h_d = \left(1 + \frac{2,35}{LFL \left(1 - \frac{1,2}{\rho} \right) + 0,05} \right) \times (0,0183 \times v^2 \times \sin^2 \phi) \quad (GG.12)$$

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 seconds 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 minutes;
- 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 seconds 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 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 ;

m_c is the **refrigerant charge** in kg;

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 seconds 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 manual the water quality necessary for the specified **heat exchanger**;
 - brine: the manufacturer shall specify in the installation manual 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 (i.e. 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 the following 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 the following 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 per 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** $m_1 < m_c \leq m_3$.

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 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, $A_{nv,\min}$, for natural ventilation to outdoors shall be calculated using the following formulae:

$$m_{\max} = \frac{\left(\frac{A_{nv}}{0,14} \right)^2}{\left(\frac{0,04}{LFL} \right)} \quad (\text{GG.20})$$

$$A_{nv,\min} = 0,14 \times \sqrt{m_c \times \frac{0,04}{LFL}} \quad (\text{GG.21})$$

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 m^2 ;

$A_{nv,min}$ is the minimum opening area in m^2 ;

0,14 is a constant derived from the gravity acceleration, flow coefficient, etc.;

0,04 is the conversion constant from hydrocarbon *LFL* to other *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 seconds 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.

$$Q_{min} = \frac{m_c - m_{max}}{4 \times LFL} \times 2 \times 60 \quad (GG.22)$$

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/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** $m_1 < m_c \leq m_3$. 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 m³/h;

m_c is the actual **refrigerant charge** for a single **refrigerating system** expressed in kg;

LFL is the **lower flammability limit** in kg/m³.

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 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 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 seconds 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** $m_1 < m_c \leq m_3$.

For appliances with more than one indoor unit, individual indoor unit cooling capacity shall not exceed 35 kW when tested in accordance with ISO 5151, ISO 13253, or ISO 15042 at T1 conditions. For heating only appliances with more than one indoor unit, individual indoor unit heating capacity shall not exceed 35 kW when tested in accordance with ISO 5151, ISO 13253, or ISO 15042 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, GG.12 or 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 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 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, GG.12 or 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:

$$v_{min} = (-4,0 \times 10^{-5} \times M^2 + 0,0108 \times M + 1,42) / \sin \varphi \quad (GG.31)$$

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 degrees is considered to be 15 degrees.

- 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 degrees and 90 degrees, 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 seconds 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 m^2 ;
- M is the molar mass in kg/kmol;
- LFL is the **lower flammability limit** expressed in kg/m^3 ;
- 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/m^3 ;
- $A_{nv,min}$ is the minimum required natural ventilation opening area in m^2 ;
- 0,14 is a constant derived from the gravity acceleration, flow coefficient, etc.;
- 0,04 is the conversion constant from hydrocarbon to other 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:

$$m_c = -\frac{10 \times V}{Q_{\min}} \ln \left(1 - \frac{Q_{\min} \times 0,25 \times LFL}{10} \right) \quad (\text{GG.35})$$

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 m³;

10 is the expected maximum leak rate in kg/h;

$Q_{\min}$ is the ventilation airflow in m³/h;

LFL is the **lower flammability limit** in kg/m³.

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:

$$m_{rl} < CF \times LFL \times H_r \times A \quad (GG.38)$$

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 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** $m_1 < m_c \leq m_2$.

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 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:

$$Q_{\min} = 3\,600 \frac{5Y \sqrt{A_o} \dot{m}_{\text{leak}}^{3/4}}{h_o^{1/4} [LFL \times (1 - CF)]^{5/8}} \quad (\text{GG.43})$$

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 9.1. 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:

$$\dot{m}_{\text{leak}} = \left(\frac{167}{432} \right) \dot{M}_s \quad (\text{GG.44})$$

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.

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 seconds 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.

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.

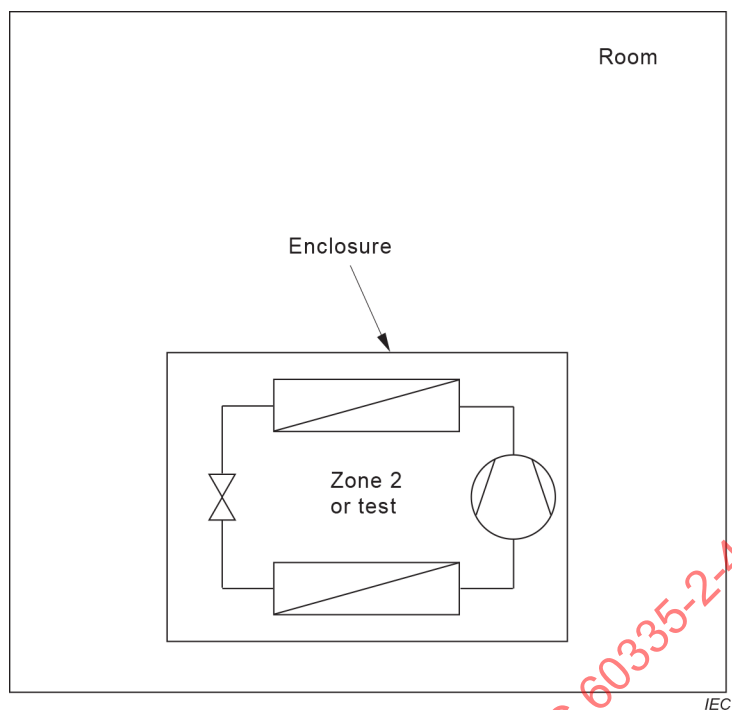


Figure GG.1 – Unventilated area

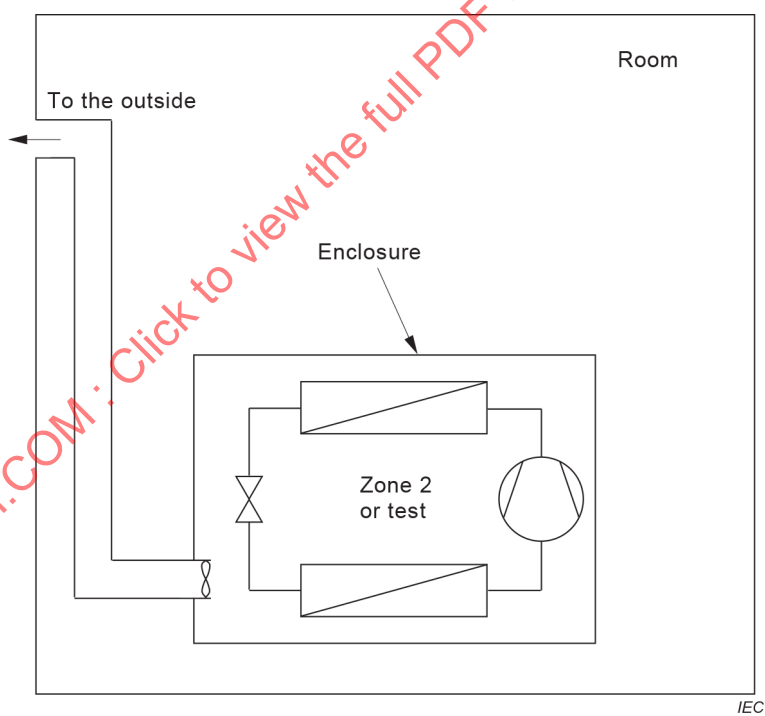


Figure GG.2 – Mechanical ventilation

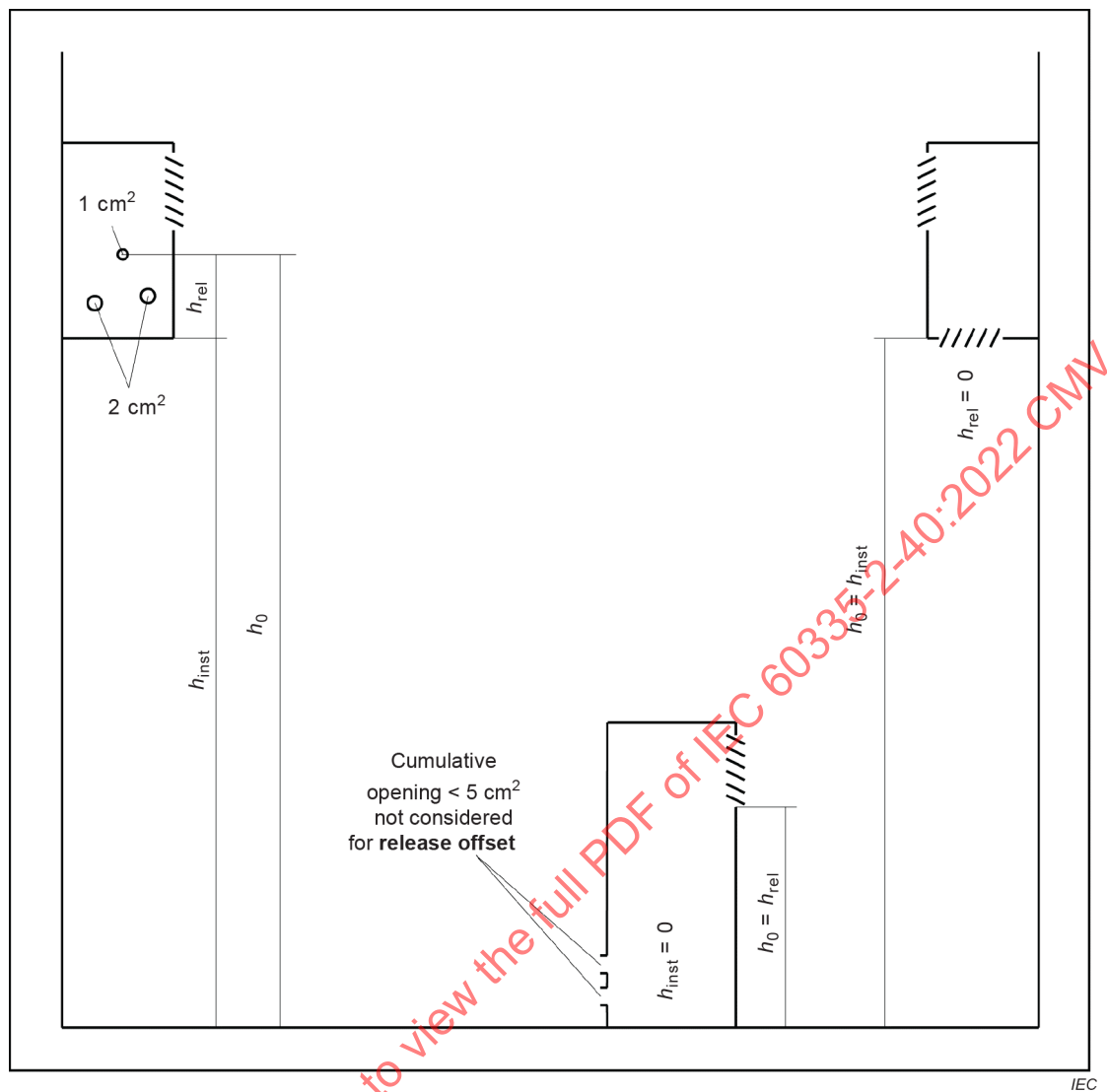
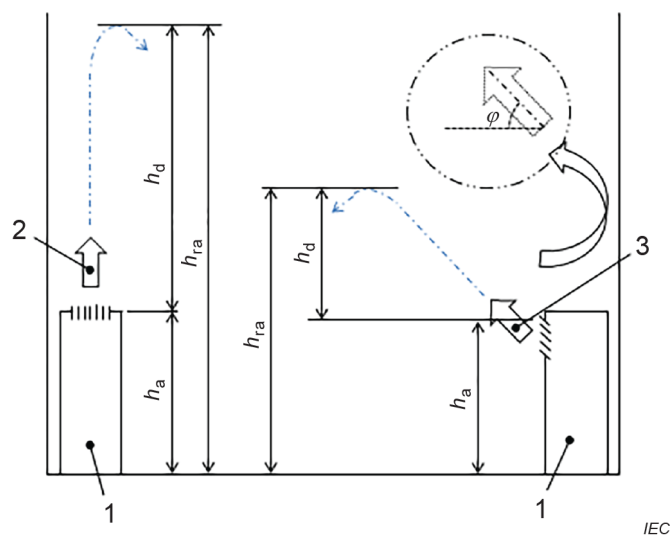


Figure GG.3 – Relevant heights h_{inst} , h_0 and h_{rel} for calculation of A_{min} and m_{max}



Key

- 1 appliance
- 2 airflow direction: Upwards (vertical $\phi = 90^\circ$)
- 3 airflow direction: Upwards

Figure GG.4 – Airflow direction

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Annex HH (informative)

Competence of service personnel

HH.1 General

Information on procedures additional to 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 organisations 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 a refrigerant leak is possible.
- Discharge capacitors in a way that won't 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 won't 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 putted 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 won't 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 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

- Follow national regulations.

Annex II
(Void)

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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.

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Annex KK (normative)

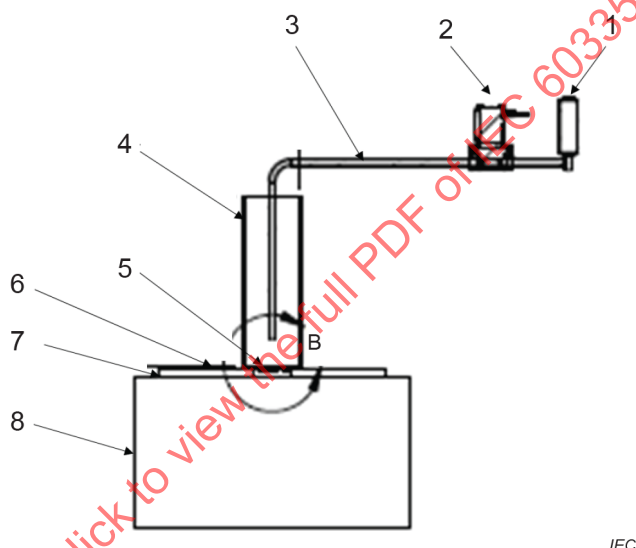
Test method for hot surface ignition temperature for A2L

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 "Standard Test Method for Discrimination Between Flammability Ratings of $F = 0$ and $F = 1$ ". The ASTM test is designed for automotive fluids as a pass fail test at 815 °C. This annex is concerned with liquefied refrigerants and defining the maximum no ignition temperature.

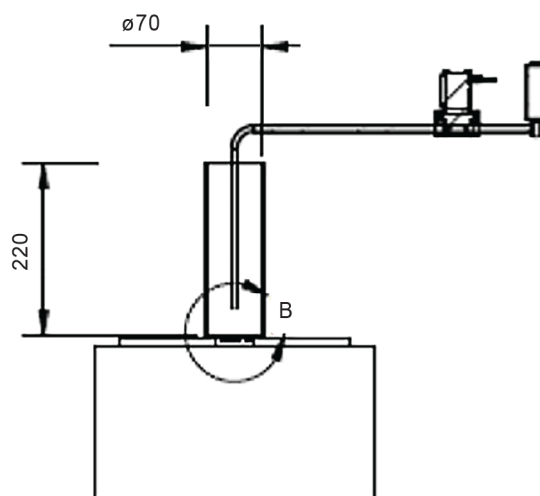


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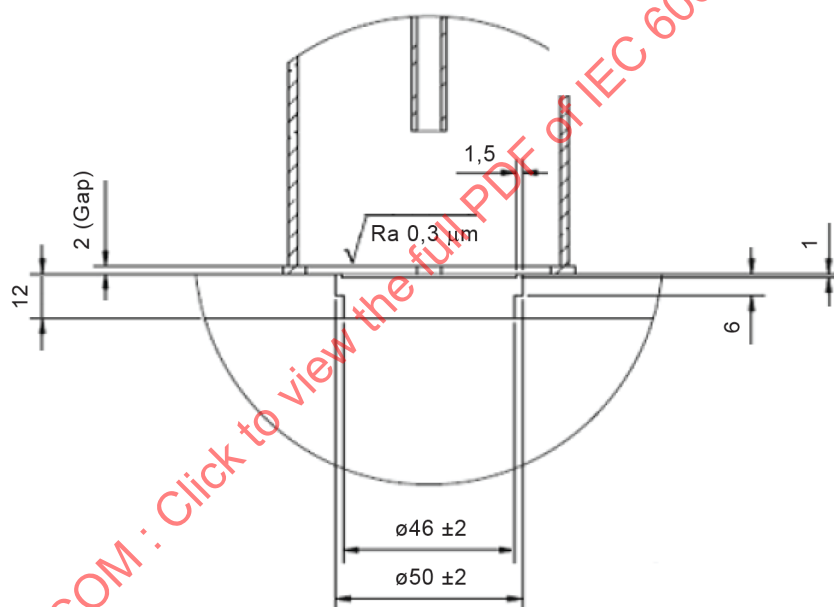
- 1 refrigerant cylinder with valve
- 2 valve
- 3 spray tube
- 4 glass cylinder
- 5 metal disc
- 6 thermocouple
- 7 insulation
- 8 hot plate

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

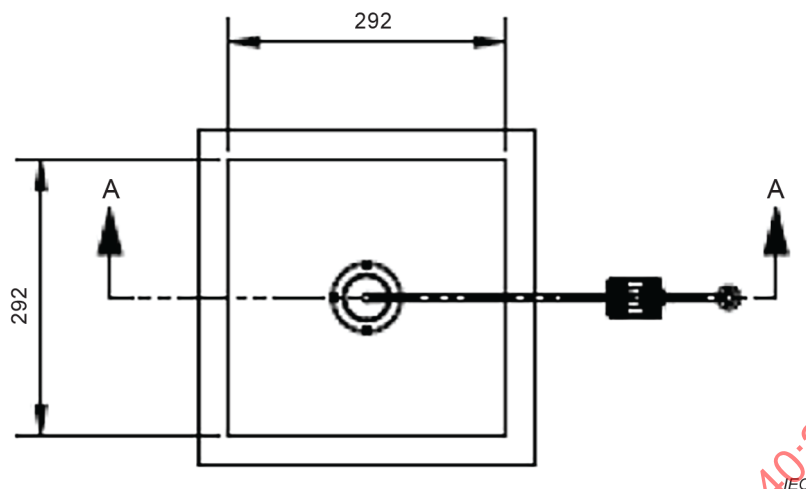


Figure KK.3 – Top view of test apparatus

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 ± 2,0 mm

Thickness: 6⁺²₀ 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 ± 0,2 cm³), tubing for directing the spray. The spray tube from valve to the end shall have the following dimensions:

Length: 250 mm ± 5,0 mm

Outer diameter: ≤ 4 mm

Inner diameter: 1,6 mm ± 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 ± 10 mm long and have a 70 mm ± 10 mm inner diameter. The chimney shall be supported so that it is vertically mounted and has a gap of 2,5 mm ± 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 ± 3 °C and 50 % RH ± 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 at 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 $\pm 15\text{ }^{\circ}\text{C}$ of the set-point during the test.
- b) Refrigerant used for the test shall be the nominal composition (NC) per 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 given 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 $800\text{ }^{\circ}\text{C}$. If ignition occurs, then the plate temperature is to be reduced in increments of $20\text{ }^{\circ}\text{C}$ 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 highest temperature with no ignition in five trials.

Annex LL (normative)

Refrigerant detection systems for flammable refrigerants

LL.1 General

This annex applies to **refrigerant detection systems** for use in appliances using **flammable refrigerants**.

Refrigerant detection systems shall give an output signal at a predetermined alarm set point in response to leaked refrigerant.

Refrigerant detection systems may respond directly to the refrigerant concentration or may respond to gases being displaced by the refrigerant.

In this annex, where **LFL** is referenced and for refrigerant used for all tests, the composition shall be the nominal composition as specified in Annex BB.

The **refrigerant detection systems** shall be capable of detecting refrigerant concentration above the alarm set point, for the refrigerant marked on the appliance, over the full range of operating temperature and humidity as specified by the appliance manufacturer. Worst case combined effects of declared manufacturing tolerances and drift shall be considered.

The tests of Clauses LL.5, LL.6, LL.7, and LL.11 are carried out on 3 separate samples for each clause; these samples shall not be used for other tests. All samples shall pass the tests.

The tests in other clauses of Annex LL shall be done with 3 samples and the tests are carried out in the following order: Clause LL.4, Clause LL.8, Clause LL.9, Clause LL.10, Clause LL.3. All samples shall pass the tests.

LL.2 Test gases and default test conditions

For the test in Clause LL.3, the test gas shall be 24 % to 25 % of **LFL**.

For the test in Clause LL.4, the low ratio test gas shall be $(3 \pm 0,3)$ % of **LFL** below the alarm set point declared by the manufacturer, but no lower than $(1,1 \pm 0,1)$ % of **LFL**.

For the test in Clause LL.4, the high ratio test gas shall be $(3 \pm 0,3)$ % of **LFL** above the alarm set point declared by the manufacturer, but no higher than $(24,7 \pm 0,3)$ % of **LFL**.

For the tests in LL.5.9, Clause LL.6, Clause LL.7, Clause LL.8, Clause LL.9, and Clause LL.10, the low ratio test gas shall be $(6 \pm 0,6)$ % of **LFL** below the alarm set point declared by the manufacturer, but no lower than $(1,1 \pm 0,1)$ % of **LFL**.

For the tests in LL.5.9, Clause LL.6, Clause LL.7, Clause LL.8, Clause LL.9, and Clause LL.10, the high ratio test gas shall be $(6 \pm 0,6)$ % of **LFL** above the alarm set point declared by the manufacturer, but no higher than $(24,7 \pm 0,3)$ % of **LFL**.

Table LL.1 illustrates the relationship between alarm set point, tolerances, and test gas concentrations.

For the test in Clause LL.11, the test gas shall be $(110 \pm 0,5)$ % of the stoichiometric concentration.

The test shall be made in a test gas chamber which construction shall be such as to ensure that the apparatus is exposed to a specific volume ratio of test gas in a reproducible manner.

Unless otherwise specified, the following conditions shall be maintained within the test gas chamber:

- *at constant temperature ± 2 °C within the range 15 °C to 25 °C throughout the duration of each test;*
- *at constant relative humidity ± 10 % RH within the range 30 % RH to 70 % RH throughout the duration of each test;*
- *at constant pressure ± 1 kPa within the range of 86 kPa to 108 kPa throughout the duration of the test.*

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Table LL.1 – Relationship among alarm set point, tolerance and test gas (informative)

Alarm set point	Clause LL.4						Subclause LL.5.9, Clause LL.6 , Clause LL.7, Clause LL.8, Clause LL.9, and Clause LL.10					
	Tolerance of refrigerant detection system: $\pm 2,5$ % of LFL		Low ratio test gas: $(3 \pm 0,3)$ % of LFL below the alarm set point, but no lower than $(1,1 \pm 0,1)$ % of LFL		High ratio test gas: $(3 \pm 0,3)$ % of LFL above the alarm set point, but no higher than $(24,7 \pm 0,3)$ % of LFL		Tolerance of refrigerant detection system: $\pm 5,0$ % of LFL		Low ratio test gas: $(6 \pm 0,3)$ % of LFL below the alarm set point, but no lower than $(1,1 \pm 0,1)$ % of LFL		High ratio test gas: $(6 \pm 0,3)$ % of LFL above the alarm set point, but no higher than $(24,7 \pm 0,3)$ % of LFL	
	Lower limit	Upper limit	Low ratio test gas, min.	Low ratio test gas, max.	High ratio test gas, min.	High ratio test gas, max.	Lower limit	Upper limit	Low ratio test gas, min.	Low ratio test gas, max.	High ratio test gas, min.	High ratio test gas, max.
% LFL	% LFL	% LFL	% LFL	% LFL	% LFL	% LFL	% LFL	% LFL	% LFL	% LFL	% LFL	% LFL
1,0	1,0	3,5	1,0	1,2	3,7	4,3	1,0	6,0	1,0	1,2	6,7	7,3
2,0	1,0	4,5	1,0	1,2	4,7	5,3	1,0	7,0	1,0	1,2	7,7	8,3
3,0	1,0	5,5	1,0	1,2	5,7	6,3	1,0	8,0	1,0	1,2	8,7	9,3
4,0	1,5	6,5	1,0	1,3	6,7	7,3	1,0	9,0	1,0	1,2	9,7	10,3
5,0	2,5	7,5	1,7	2,3	7,7	8,3	1,0	10,0	1,0	1,2	10,7	11,3
6,0	3,5	8,5	2,7	3,3	8,7	9,3	1,0	11,0	1,0	1,2	11,7	12,3
7,0	4,5	9,5	3,7	4,3	9,7	10,3	2,0	12,0	1,0	1,3	12,7	13,3
8,0	5,5	10,5	4,7	5,3	10,7	11,3	3,0	13,0	1,7	2,3	13,7	14,3
9,0	6,5	11,5	5,7	6,3	11,7	12,3	4,0	14,0	2,7	3,3	14,7	15,3
10,0	7,5	12,5	6,7	7,3	12,7	13,3	5,0	15,0	3,7	4,3	15,7	16,3
11,0	8,5	13,5	7,7	8,3	13,7	14,3	6,0	16,0	4,7	5,3	16,7	17,3
12,0	9,5	14,5	8,7	9,3	14,7	15,3	7,0	17,0	5,7	6,3	17,7	18,3
13,0	10,5	15,5	9,7	10,3	15,7	16,3	8,0	18,0	6,7	7,3	18,7	19,3
14,0	11,5	16,5	10,7	11,3	16,7	17,3	9,0	19,0	7,7	8,3	19,7	20,3
15,0	12,5	17,5	11,7	12,3	17,7	18,3	10,0	20,0	8,7	9,3	20,7	21,3
16,0	13,5	18,5	12,7	13,3	18,7	19,3	11,0	21,0	9,7	10,3	21,7	22,3
17,0	14,5	19,5	13,7	14,3	19,7	20,3	12,0	22,0	10,7	11,3	22,7	23,3
18,0	15,5	20,5	14,7	15,3	20,7	21,3	13,0	23,0	11,7	12,3	23,7	24,3
19,0	16,5	21,5	15,7	16,3	21,7	22,3	14,0	24,0	12,7	13,3	24,4	25,0
20,0	17,5	22,5	16,7	17,3	22,7	23,3	15,0	25,0	13,7	14,3	24,4	25,0
21,0	18,5	23,5	17,7	18,3	23,7	24,3	16,0	25,0	14,7	15,3	24,4	25,0
22,0	19,5	24,5	18,7	19,3	24,4	25,0	17,0	25,0	15,7	16,3	24,4	25,0
23,0	20,5	25,0	19,7	20,3	24,4	25,0	18,0	25,0	16,7	17,3	24,4	25,0
24,0	21,5	25,0	20,7	21,3	24,4	25,0	19,0	25,0	17,7	18,3	24,4	25,0
25,0	22,5	25,0	21,7	22,3	24,4	25,0	20,0	25,0	18,7	19,3	24,4	25,0

LL.3 Response time of the refrigerant detection system

Refrigerant detection system shall give an output signal within 30 seconds when the **refrigerant sensor** is put into refrigerant concentration of 25 % of **LFL**.

Compliance is checked by test.

*The test shall be conducted after the warm-up time for the **refrigerant sensor** has elapsed.*

*Expose the **refrigerant sensor** to a step change in the gas volume ratio from clean air to the test gas specified in Clause LL.2 within 5 s.*

*The **refrigerant detection system** shall give an output signal within 30 seconds after the step change is completed.*

*Expose the **refrigerant sensor** to clean air. If the **refrigerant detection system** gives an output signal indicating a leak after 5 hours of exposure to clean air, then the **refrigerant detection system** or the appliance shall provide notification to the user that replacement of the **refrigerant sensor** is required (see also 22.122).*

The samples shall not be used for subsequent tests.

LL.4 Refrigerant detection system calibration and short-term stability

The **refrigerant detection systems** shall have an alarm set point and be calibrated from the factory for the refrigerant marked on the appliance.

The **refrigerant detection system** shall consistently give an output signal at the alarm set point with a tolerance of $\pm 2,5$ % of **LFL**, but not lower than 1 % of **LFL**.

The alarm set point shall not be adjustable. Recalibration other than self-recalibration shall not be allowed.

Compliance is checked by inspection and test.

*To confirm the pre-set alarm set point, the **refrigerant detection system** shall respond as intended when tested as follows:*

- The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal within this time.*
- The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal within this time.*

Repeat twice after the initial test with a 5 min interval between tests.

LL.5 Selectivity test and poisoning test

LL.5.1 Refrigerant detection system including **refrigerant sensors** shall not have false or nuisance trips, and not be subject to poisoning.

After being exposed to the gases in Table LL.2, the **refrigerant detection system** shall consistently give an output signal at the alarm set point with a tolerance of ± 5 % of **LFL**, but not lower than 1 % of **LFL**.

Compliance is checked by the following test.

LL.5.2 *The **refrigerant sensor** shall be exposed sequentially, as described in LL.5.4 to LL.5.8, to the concentrations of gases and vapours shown in Table LL.2.*

Table LL.2 – Gas and vapour concentrations

Substance	Concentration, ppm
Methane	500
n-Butane	300
n-Heptane	500
Ethyl acetate	200
Isopropyl alcohol	200
Carbon dioxide	5 000
Ammonia	100
Ethanol	200
Toluene	200
Acetone	200
Hexamethyldisiloxane	110
ppm: parts per million.	

LL.5.3 Based on the interior volume of the test chamber used in LL.5.1, calculate the amount of each test substance necessary to supply the concentrations given in Table LL.2.

LL.5.4 Ensure that the chamber has been well ventilated with fresh air. Place the **refrigerant sensor** in operation inside the chamber and allow it to run for 15 minutes $\pm$ 5 minutes. Close and seal the chamber to prevent air infiltration.

LL.5.5 Using a syringe or equivalent device, add the calculated amount of the first substance into the chamber at a rate and in a location such that it is well mixed with the air and does not cause localized high concentrations.

LL.5.6 Allow the **refrigerant sensor** to remain in the chamber for 2 hours. During this time, the output signal shall not indicate the presence of refrigerant concentration above the alarm set point.

LL.5.7 Purge the chamber with clean air to remove all of the test atmosphere. Maintain clean air in the chamber for a recovery time of 16 hours or as specified by the manufacturer. In no case shall recovery time exceed 16 hours.

LL.5.8 Reseal the chamber and repeat the test using another substance from Table LL.2 until the **refrigerant sensor** has been exposed to all substances. It is not required that exposure to the substances be in any particular order.

LL.5.9 At the end of the test:

- The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal within this time.
- The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal within this time.

LL.6 Refrigerant poisoning and oil spray test

LL.6.1 General

The **refrigerant detection system** shall not be subject to poisoning or damage by the refrigerant(s) marked on the appliance mixed with oil.

After being exposed to the refrigerant(s) marked on the appliance mixed with oil, the **refrigerant detection system** shall

- consistently give an output signal at the alarm set point with a tolerance of $\pm 5\%$ of **LFL**, but not lower than 1% of **LFL**, and shall give an output signal within 60 seconds when the **refrigerant sensor** is put into refrigerant concentration of 25% of **LFL**, or
- give an output signal indicating a refrigerant leak and notify the user that the **refrigerant sensor** needs to be replaced. The output signal shall continue until the **refrigerant sensor** has been replaced.

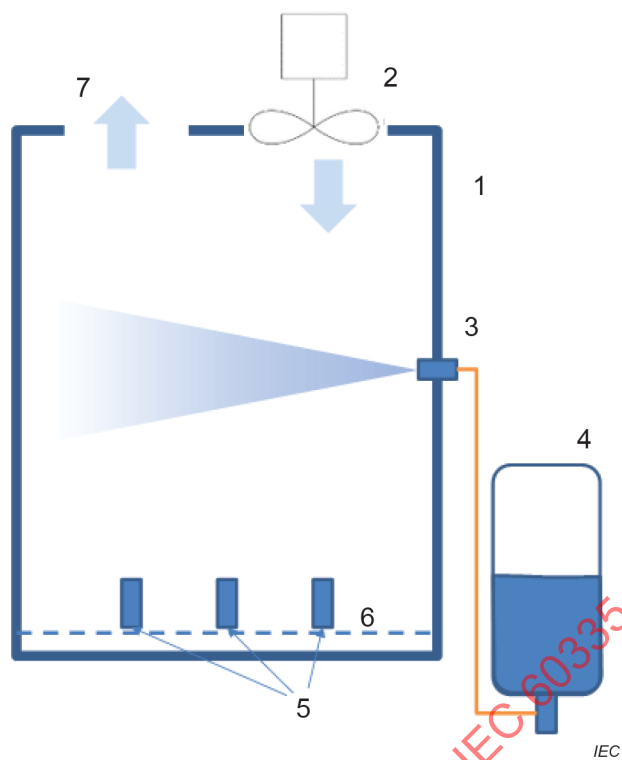
LL.6.2 Test set-up

- a) *The test vessel shall be cylindrical shape and have enough bottom area to accommodate 3 sample **refrigerant sensors** to be placed without contact at bottom level.*
- b) *The **refrigerant sensors** shall be placed in the vessel on a grid that is $2\text{ cm} \pm 0,5\text{ cm}$ above the bottom of the vessel with orientation in accordance with the manufacturer's instructions.*
- c) *Height of the vessel shall be greater than the diameter of the vessel, but less than 2 times the diameter.*
- d) *An orifice size shall be chosen to release refrigerant at a rate of $200\% \pm 20\%$ of the vessel volume per minute, based on $0,022\text{ 4 m}^3/\text{mol}$.*
- e) *The orifice shall be located at the middle of the vessel height and directed to make a horizontal release of refrigerant.*
- f) *Liquid refrigerant shall contain $2\% \pm 0,2\%$ of oil to be used in the appliance or other miscible oil with the refrigerant between 15°C and 30°C .*
- g) *The refrigerant and oil mixture shall be taken from the liquid phase.*

NOTE 1 This can be accomplished by using a refrigerant cylinder with a dip tube or the refrigerant cylinder can be placed upside down to ensure the release is taken from the liquid phase.

- h) *The total amount of refrigerant per release with lubricant shall be $800\% \pm 80\%$ of the vessel volume, based on $0,022\text{ 4 m}^3/\text{mol}$.*
- i) *A ventilation fan with nominal flow rate to dilute the released refrigerant to $50\% \pm 10\%$ of **LFL** shall be provided at the top plate of the vessel to introduce fresh air to the vessel.*
- j) *The output signal of one **refrigerant detection system** shall be wired to make the ventilation fan operate 15 seconds after the **refrigerant detection system** gives an output.*
- k) *An exhaust opening shall be provided, also at the top plate of the vessel, to have velocity less than 1 m/s based on the nominal airflow rate of the fan. The exhaust opening shall have a minimum area of 100 cm^2 .*

NOTE 2 An example of a test set-up design is given in Figure LL.1 and Table LL.3.



Key

- 1 test vessel
- 2 fan
- 3 spray orifice
- 4 cylinder for refrigerant-oil mix
- 5 test samples
- 6 floor grid (raised from floor)
- 7 exhaust opening

Figure LL.1 – Example of test chamber design

Table LL.3 – Example of the test chamber design

Vessel volume	20 L (5 gal) pail
Refrigerant	R-32 (Molar mass 52 kg/kmol; LFL 0,306 kg/m ³)
Release rate	1,5 g/s Verification: 1,5 g/s is $1,5 \times 60 = 90$ g/min, this is $90 / 52 = 1,73$ mol/min, or $1,73 \times 0,022\ 4 = 0,038\ 8$ m³/min. - In % of vessel volume 1,5 g/s is $0,038\ 8 / 0,02 \times 100 = 194$ % of vessel volume per minute. - This is within the accepted tolerance range.
Release amount	360 g including (7,2 ± 0,72) g of lubricant Released in approximately 4 minutes (total amount has priority than the release duration)
Ventilation rate	0,6 m ³ /min Verification: - The required ventilation is $1,5\ \text{g/s} \times 0,001\ \text{kg/g} \times 60\ \text{s/min} / (0,50 \times 0,306\ \text{kg/m}^3) = 0,588\ \text{m}^3/\text{min}$. - The ventilation rate is within the accepted tolerance range.
Opening area for exhaust	Square opening 100 mm × 100 mm, or round opening with 112 mm diameter.
Orifice size	Diameter 0,8 mm to 1,0 mm

LL.6.3 Test procedure

A set-up according to LL.6.2 shall be provided.

- Start the release of refrigerant with oil at the specified rate.
- The ventilation fan shall be activated 15 seconds after the **refrigerant detection system** gives an output signal.
- Maintain the release of refrigerant with oil until the specified amount is released. This will take approximately 4 minutes from the start of the release.
- Maintain the ventilation fan operation at least 5 minutes after the reset of the **refrigerant detection system**.
- If the **refrigerant detection system** or the appliance provides notification to the user that replacement of the **refrigerant sensor** is required (see also 22.122), then the **refrigerant detection system** shall give an output signal indicating a leak until the **refrigerant sensor** has been replaced (see also 22.122) and the test shall be terminated.
- Stop ventilation fan.
- Test according to LL.6.4.
- Repeat steps of a) to g) for a total of 5 times.

LL.6.4 Check of alarm set point and response time

The **refrigerant detection system** shall respond as intended when tested as follows:

- The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal.
- The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal.
- Expose the **refrigerant sensor** to clean air for (15 ± 5) minutes.

- d) Expose the **refrigerant sensor** to a step change in the gas volume ratio from clean air to 24 % to 25 % of **LFL** within 5 s.
- e) The **refrigerant detection system** shall give an output signal within 60 seconds after the step change is completed.

LL.7 Long term stability

Over a period of 90 days, the **refrigerant detection system** shall consistently give an output signal at the alarm set point with a tolerance of ± 5 % of **LFL**, but not lower than 1 % of **LFL**.

Compliance is checked by the following test:

The **refrigerant sensor** shall be exposed to clean air and energized continuously for a period of 90 days. The constant pressure requirement of Clause LL.2 shall not apply to this test. Every 15 days:

- The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal within this time.
- The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal within this time.

LL.8 Humidity test

Over the humidity range of the appliance, the **refrigerant detection system** shall consistently give an output signal at the alarm set point with a tolerance of ± 5 % of **LFL**, but not lower than 1 % of **LFL**.

NOTE Condensation can occur on refrigerant sensors. This is not considered by Annex LL.

Compliance is checked by the following test:

The **refrigerant sensor** shall be exposed for 60 min to clean air humidified to (30 ± 5) % RH at (15 ± 2) °C.

To confirm the pre-set alarm set point, the **refrigerant detection system** shall respond as intended when tested as follows:

- The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal within this time.
- The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal within this time.

The test gases of Clause LL.2 shall also be humidified.

The procedure shall be repeated with (90 ± 5) % RH at (40 ± 2) °C.

LL.9 Temperature test

Over the temperature range of the appliance, the **refrigerant detection system** shall consistently give an output signal at the alarm set point with a tolerance of ± 5 % of **LFL**, but not lower than 1 % of **LFL**.

Compliance is checked by the following test:

Place the **refrigerant sensor** in operation inside a chamber having the capability of holding the **refrigerant sensor** at the specified temperatures within ± 2 K. The **refrigerant sensor** shall be acclimated at each of the following temperatures for at least 3 h or until acclimated within ± 2 K for a minimum of 1 h:

- the minimum temperature that the refrigerant sensor can be exposed to in the application as declared by the manufacturer or lower;
- the maximum temperature that the refrigerant sensor can be exposed to in the application as declared by the manufacturer or higher.

To confirm the pre-set alarm set point at each temperature, the **refrigerant detection system** shall respond as intended when tested as follows:

- The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal within this time.
- The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal within this time.

LL.10 Vibration requirements

Vibration requirements this clause apply for **refrigerant sensors**. Vibration requirements for **refrigerant sensors** need not apply to the entire appliance.

Refrigerant sensors shall withstand vibration without breakage or damage of parts and shall continue to function.

After the vibration test, the refrigerant detection system shall give an output signal at the alarm set point with a tolerance of ± 5 % of **LFL**, but not lower than 1 % of **LFL**.

Compliance is checked by the following test:

The **refrigerant sensor** shall be secured to the intended mounting and in turn securely fastened to a variable speed vibration test machine having an amplitude and frequency as follows:

- 10 Hz to 31,5 Hz, with 1,0 mm total excursion, and
- 31,5 Hz to 150 Hz, with 2 g acceleration peak.

The **refrigerant sensor** shall be vibrated over the specified frequency range, displacement and acceleration for a period of 1 h in each of the three mutually perpendicular planes. The change rate shall not exceed 10 Hz/min.

Alternatively, the **refrigerant sensor** may be tested using the vibration test of 21.101.

After the vibration test, the **refrigerant detection system** shall respond as intended when tested as follows:

- The **refrigerant sensor** shall be exposed to the low ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall not give an output signal within this time.
- The **refrigerant sensor** shall be exposed to the high ratio test gas specified in Clause LL.2 for 5 minutes and the **refrigerant detection system** shall give an output signal within this time.

LL.11 Ignition test

Refrigerant sensors shall not be a source of ignition for leaked refrigerant.

Compliance is checked by test.

*The test shall be conducted after the warm-up time for the **refrigerant sensor** has elapsed.*

*Expose the **refrigerant sensor** to a step change in the gas volume ratio from clean air to the test gas specified in Clause LL.2 within 5 s.*

For compliance, no explosion nor ignition shall occur within 5 min.

LL.12 Refrigerant detection system self-test routine

The **refrigerant detection system** shall include a means for self-testing to determine if a **refrigerant sensor** electrical malfunction has occurred. The self-test shall include missing **refrigerant sensor** (open circuit), by-passed **refrigerant sensor** (shorted circuit), and **refrigerant sensor** output out of range.

The test shall be run at least every hour and if a failure is detected, the **refrigerant detection system** shall provide a dedicated notification to the end user that replacement is required.

If the **refrigerant sensor** is a **limited life refrigerant sensor** and requires replacement after a given period, then the **refrigerant detection system** shall provide notification to the user that replacement is required at the end of the specified life.

Compliance is checked by inspection.

LL.13 Serviceability

Refrigerant sensors shall be accessible for inspection and replacement. **Refrigerant sensors** for replacement shall be specified by the appliance manufacturer.

Compliance is checked by inspection.

LL.14 Refrigerant sensor identification

The **refrigerant sensors** or the parts of the appliance containing **refrigerant sensors** shall be marked or tagged with:

- "service indicator; read technical manual" (symbol ISO 7000-1659 (2004-01));
- year of manufacturing;
- reference number or other means for identifying the **refrigerant sensor**.

The marking shall be visible when servicing the **refrigerant sensors**.

Compliance is checked by inspection.

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 per 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 m²;

h_t is the height from the floor to the bottom of the unit in the test set-up in metres (m);

$\dot{m}_{\text{leak}}$ is the refrigerant leak rate in g/s;

LFL is the **lower flammability limit** in kg/m³;

- 1,2 *is the conversion factor based on limiting the test room concentration to 5 % of LFL at the end of the 60 seconds refrigerant release at a release rate of $\dot{m}_{\text{leak}}$.*

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 seconds (time constant 4,3 seconds) 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 seconds 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 seconds 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 seconds from the start of the release, the **refrigerant detection system refrigerant sensor** location shall be considered in compliance.*

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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 per 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 per 16.3 shall be conducted after the test.*

NN.2.9 *The enclosure shall be considered in compliance with this annex 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.*

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Annex OO
(Void)

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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 seconds 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 seconds 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 seconds 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 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 this annex, 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 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 per 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:

$$A_t = 2,4 \times \dot{m}_{\text{leak}} / (LFL \times h_t) \quad (\text{PP.1})$$

where

A_t is the minimum room area for the test in m²;

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/m³;

2,4 is the conversion factor based on limiting the test room concentration to 5 % of **LFL** at the end of a 120 seconds 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:

$$\dot{m}_{\text{leak}} = 4 \times LFL \quad (\text{PP.2})$$

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 minute leak of m_c and converting 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 is **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:

$$\dot{m}_{\text{leak}} = \left[\frac{Q h_o^{1/4} [LFL \times (1 - CF)]^{5/8}}{3\,600 \times 5Y \sqrt{A_o}} \right]^{4/3} \quad (\text{PP.4})$$

where

Q is the unit 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 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/m³;

CF is a concentration factor as selected for GG.14.3.1.

PP.2.2.3.3 Enhanced tightness refrigerating systems

For non-enhanced tightness refrigerating systems with A2L refrigerants the leak rate shall be maintained at:

$$\dot{m}_{\text{leak}} = CF \times LFL \times Q \times 1\,000/3\,600, \text{ but not less than } 4 \times LFL \quad (\text{PP.5})$$

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/m³;

Q is the unit airflow volume in m³/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:

$$\dot{m}_{\text{leak}} = \frac{1\,000 \times Q \, m_c^{1/4} \, LFL^{3/4}}{3\,600 \times 8Y \sqrt{A_o}} \left(\frac{1 - CF}{CF^{1/4}} \right) \quad (\text{PP.6})$$

where

$\dot{m}_{\text{leak}}$ is the refrigerant leak rate in g/s;

Q is the unit airflow volume in m³/h;

1 000 is a constant to convert kg to g;

3 600 is a constant to convert m³/s to m³/h;

8 is a constant;

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;

m_c is the actual **refrigerant charge** amount in the system in kg;

LFL is the **lower flammability limit** in kg/m³;

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:*

$$A_o = 4 \times LFL / 1,7 \quad (\text{PP.7})$$

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 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.

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.

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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 to this annex.

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, QQ.3, or QQ.4.

NOTE 3 The **releasable charge** can be determined by calculation, measurement or a combination, 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 3 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 minutes 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 3 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 minutes 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 hours, 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:*

$$m_{rl} = m_c - m_{ret} \quad (QQ.1)$$

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 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 minutes, 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 3 times and the **releasable charge** shall be 2 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 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 leak is detected as determined in Clause QQ.5 in s;

m_{r2} is the charge released between detection and closing the shut-off valves as determined in QQ.4.2 in kg;

m_{r3} is the refrigerant released after closing the 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 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, $\rho_{\text{part},i}$, by measuring the pressure according to QQ.4.3.2;
- determine apparent density, $\rho_{\text{part},i}$, by applying default values according to QQ.4.3.3;
- determine apparent density, $\rho_{\text{part},i}$, 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:

$$m_{r3} = \sum V_{\text{part},i} \times \rho_{\text{part},i} \quad (\text{QQ.5})$$

where

$V_{\text{part},i}$ is the free internal volume in the evaluated part i in m^3 ;

$\rho_{\text{part},i}$ is the apparent density of in the evaluated part i in kg/m^3 .

QQ.4.3.2 Determine apparent density, $\rho_{\text{part},i}$, by measuring the pressure

To determine the apparent density, $\rho_{\text{part},i}$, 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 minutes.*

For the test in standby mode, the system shall be stopped for 8 hours after the cooling operation according to the condition specified in Clause QQ.6 for 30 minutes.

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, $\rho_{part,i}$, 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, $\rho_{part,i}$, 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, $\rho_{part,i}$, 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, $\rho_{part,i}$, by measuring the recovered refrigerant amount from the unit or piping

To determine the apparent density, $\rho_{part,i}$, 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 minutes 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 minutes, and then stopped for 8 hours.

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 3 times and the measured refrigerant amount, m_{rm} , shall be 2 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 Clause LL.3. 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:

$$t_{r1} = (H_r \times A_{min} \times LFL \times C_{set} / 0,002\ 8) + 30 \quad (QQ.7)$$

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 Clause LL.3.

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.

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SOMMAIRE

AVANT-PROPOS	161
INTRODUCTION.....	164
1 Domaine d'application	165
2 Références normatives	166
3 Termes et définitions	168
4 Exigences générales	176
5 Conditions générales d'essais	176
6 Classification.....	177
7 Marquage et instructions	177
8 Protection contre l'accès aux parties actives.....	183
9 Démarrage des appareils à moteur	183
10 Puissance et courant	183
11 Échauffements.....	183
12 Vide.....	187
13 Courant de fuite et rigidité diélectrique à la température de régime	187
14 Surtensions transitoires	187
15 Résistance à l'humidité.....	187
16 Courant de fuite et rigidité diélectrique	188
17 Protection contre la surcharge des transformateurs et des circuits associés	189
18 Endurance	189
19 Fonctionnement anormal	189
20 Stabilité et dangers mécaniques	196
21 Résistance mécanique.....	196
22 Construction	197
23 Conducteurs internes.....	211
24 Composants	211
25 Raccordement au réseau et câbles souples extérieurs	212
26 Bornes pour conducteurs externes	213
27 Dispositions en vue de la mise à la terre	213
28 Vis et connexions	213
29 Distances dans l'air, lignes de fuite et isolation solide.....	213
30 Résistance à la chaleur et au feu.....	214
31 Protection contre la rouille	215
32 Rayonnement, toxicité et dangers analogues.....	215
Annexes	222
Annexe D (normative) Protecteurs thermiques des moteurs	222
Annexe I (normative) Moteurs ayant une isolation principale inappropriée pour la tension assignée de l'appareil.....	222
Annexe AA (informative) Exemples de températures de régime de l'appareil	223
Annexe BB (normative) Informations concernant les fluides frigorigènes.....	225
Annexe CC (informative) Transport, marquage et entreposage des unités qui utilisent des fluides frigorigènes inflammables	229

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	231
Annexe EE (normative) Essais de pression	241
Annexe FF (normative) Essais de simulation de fuite	243
Annexe GG (normative) Limites de charge, exigences de ventilation et exigences pour les circuits secondaires	245
Annexe HH (Informative) Compétences du personnel de service	279
Annexe II (vide)	282
Annexe JJ (normative) Ouvertures admissibles des relais et composants analogues pour empêcher l'inflammation des fluides frigorigènes A2L	283
Annexe KK (Normative) Méthode d'essai pour la température d'inflammation des surfaces brûlantes des fluides frigorigènes A2L	285
Annexe LL (normative) Systèmes de détection des fluides frigorigènes pour les fluides frigorigènes inflammables	289
Annexe MM (normative) Essai de confirmation de l'emplacement du capteur de fluide frigorigène	301
Annexe NN (normative) Essai de vérification de l'enveloppe arrête-flammes pour les fluides frigorigènes A2L	304
Annexe OO (vide)	306
Annexe PP (normative) Essai de confirmation du système de détection des fuites pour les fluides frigorigènes inflammables	307
Annexe QQ (Normative) Méthodes d'essai pour la détermination de la charge libérable	313
Bibliographie.....	321
Figure 101 – Exemple d'étiquette pour les unités chargées sur place.....	217
Figure 102 – Montage d'essai d'échauffement pour les appareils comportant un chauffe-air supplémentaire.....	219
Figure 103 – Circuit d'alimentation pour l'essai en rotor bloqué d'un moteur monophasé – à réviser au besoin pour l'essai triphasé	220
Figure 104 – Profil de densité spectrale de puissance pour l'essai de vibration du 21.101	220
Figure 105 – Détails dimensionnels du poids dans la zone de la bille de pression.....	220
Figure 106 – Mesurage avant et après l'essai	221
Figure GG.1 – Zones non ventilées.....	276
Figure GG.2 – Ventilation mécanique.....	276
Figure GG.3 – Hauteurs appropriées h_{inst} , h_0 et h_{rel} pour le calcul de A_{min} et de m_{max}	277
Figure GG.4 – Direction du débit d'air	278
Figure KK.1 – Vue de face des étiquettes de l'appareillage d'essai	285
Figure KK.2 – Appareillage d'essai avec dimensions.....	286
Figure KK.3 – Vue du dessus de l'appareillage d'essai	287
Figure LL.1 – Exemple de conception d'une chambre d'essai.....	295
Tableau 101 – Profil de densité spectrale de puissance pour l'essai de vibration	196
Tableau 102 – Emplacement de mesure de l'éclairement spectral UV-C	216
Tableau AA.1 – Exemples de températures de régime de l'appareil	223

Tableau BB.1 – Informations concernant les fluides frigorigènes.....	225
Tableau DD.1 – Articles obligatoires dans chaque manuel.....	231
Tableau GG.1 – Aperçu de l'Annexe GG (informative)	246
Tableau GG.2 – Débit d'air de circulation.....	251
Tableau GG.3 – Appareil avec emballage	258
Tableau GG.4 – Appareil sans emballage	259
Tableau GG.5 – Vitesse minimale de l'air.....	271
Tableau GG.6 – Débit de fuite du fluide frigorigène ($\dot{m}_{\text{leak}}$).....	274
Tableau LL.1 – Relation entre le point de consigne de l'alarme, la tolérance et le gaz d'essai (informatif)	291
Tableau LL.2 – Concentrations de gaz et de vapeur	293
Tableau LL.3 – Exemple de conception de la chambre d'essai.....	296

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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

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L'IEC 60335 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 septième édition annule et remplace la sixième édition parue en 2018. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

- Article 1 – ajout des **pompes à chaleur thermoélectriques** au domaine d'application et augmentation de la **tension assignée** maximale à 300 V pour les appareils monophasés;

- Article 7 – révision des exigences relatives au marquage sur l'appareil et l'emballage, y compris un symbole relatif à la surface au sol minimale, et modification du symbole relatif aux **fluides frigorigènes inflammables** afin d'inclure le groupe de sécurité selon l'ISO 817;
- Article 11 et Article 19 – restructuration à des fins d'alignement sur la Partie 1 et ajout d'exigences relatives au **chauffe-air supplémentaires**;
- Article 13 et Article 16 – révision de l'exigence relative au courant de fuite des **appareils fixes à moteur de classe I**;
- Article 21 – ajout d'exigences relatives au **matériau en mousse de particules** et révision des exigences relatives aux essais de transport;
- Article 22 – suppression de la limite pour la somme des **charges de fluide frigorigène** des appareils équipés de plusieurs **systèmes frigorifiques** et révision des exigences afin d'éviter les sources d'inflammation, les **systèmes de détection des fuites**, les **vannes d'arrêt de sécurité** et le **matériau en mousse de particules**;
- Article 23 – ajout d'exigences visant à éviter le contact entre les conducteurs et la tuyauterie de fluide frigorigène;
- Article 24 – révision des exigences relatives aux motocompresseurs;
- Article 30 – ajout d'exigences en matière de résistance à la chaleur du **matériau en mousse de particules**;
- Annexe BB – révision du Tableau BB.1 avec des informations relatives aux fluides frigorigènes et ajout d'un lien vers les données sur les fluides frigorigènes de l'ISO 817;
- Annexe DD – révision des exigences relatives aux informations contenues dans le manuel pour les appareils qui utilisent des **fluides frigorigènes inflammables**;
- Annexe EE – révision des exigences relatives aux essais de pression;
- Annexe FF – révision des exigences relatives aux essais de simulation de fuite;
- Annexe GG – ajout d'exigences relatives à l'application de la **charge libérable**, ajout d'une couverture supplémentaire pour les fluides frigorigènes A2 et A3, y compris de nouvelles limites de charge pour les appareils à **débit d'air de circulation** et pour les **systèmes frigorifiques à étanchéité renforcée**, et révision des exigences relatives aux **systèmes frigorifiques à étanchéité renforcée** qui utilisent le **fluide frigorigène A2L**;
- Annexe LL – révision des exigences relatives aux **systèmes de détection des fluides frigorigènes**;
- Annexe MM – révision du taux de fuite simulé;
- Annexe OO – suppression de l'annexe relative au conditionnement du câblage interne à l'aide de la lumière UV.
- Annexe PP – nouvelle couverture de l'essai de confirmation du **système de détection des fuites**;
- Annexe QQ – nouvelle couverture de la méthode pour la détermination de la **charge libérable**;

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
61D/491/FDIS	61D/493/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.

Le présent 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/standardsdev/publications.

La présente Partie 2-40 doit être utilisée conjointement avec l'IEC 60335-1:2010, son Amendement 1:2013 et son Amendement 2:2016.

NOTE 1 L'expression "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 de sécurité pour les pompes à chaleur électriques, les climatiseurs et les déshumidificateurs.

Lorsqu'un paragraphe particulier de la Partie 1 n'est pas mentionné dans la présente Partie 2, ce paragraphe s'applique pour autant que cela soit raisonnable. Lorsque la présente norme indique "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 sont ajoutés à ceux de la Partie 1 sont numérotés à partir de 101;
- les notes, à l'exception de celles qui sont dans un nouveau paragraphe ou de celles qui concernent des notes de la Partie 1, sont numérotées à partir de 101, y compris celles des articles ou paragraphes qui sont modifiés ou remplacés;
- les annexes supplémentaires sont appelées AA, BB, etc.

NOTE 3 Les caractères d'imprimerie suivants sont utilisés:

- exigences: caractères romains;
- *modalités d'essai: 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 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).

Une liste de toutes les parties de la série IEC 60335, publiées sous le titre général: *Appareils électrodomestiques et analogues – Sécurité*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu du présent 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. A cette date, le document sera

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INTRODUCTION

Il a été estimé, 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 recommandation concernant l'application des exigences de sécurité pour les appareils sont accessibles par les documents de soutien du CE 61 sur le site web de l'IEC

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

Cette information est donnée à l'intention des utilisateurs de la présente Norme internationale et ne constitue aucunement un remplacement du texte normatif de la présente norme.

La présente norme reconnaît le niveau de protection internationalement accepté contre les dangers 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 auxquelles il est possible de s'attendre 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 nationales d'installation peuvent être différentes.

Si un appareil relevant du domaine d'application de la présente norme comporte également des fonctions qui sont 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. Le cas échéant, 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 prévaut sur les normes horizontales et génériques couvrant le même sujet.

NOTE 2 Les publications horizontales, les publications de sécurité de base et les publications groupées de sécurité qui couvrent un danger ne sont pas applicables 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 n'est 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 qui utilise des matériaux ou présente des modes de construction différents de ceux décrits dans les exigences de la présente norme peut être examiné et soumis aux essais conformément à l'objectif poursuivi par ces exigences et, s'il est jugé pratiquement équivalent, il peut être estimé conforme à la norme.

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 appareils multiphasés.

Les appareils non destinés à un usage domestique normal, mais qui néanmoins peuvent 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. Si les appareils sont fournis en plusieurs ensembles, les ensembles doivent être 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 tels qu'ils sont définis par 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 suppose que l'installation, l'entretien, la mise hors service et l'élimination sont effectués en toute sécurité par des personnes compétentes et que le dégagement accidentel de fluides frigorigènes est évité. Toutefois, elle ne prescrit pas les critères qui permettent de garantir la compétence des personnes lors de l'installation, de l'entretien et de l'élimination. Les exigences de sécurité pendant l'élimination ne sont pas spécifiées dans la présente norme.

NOTE 103 L'Annexe HH fournit des exigences informatives relatives à la compétence des personnes. Les critères de compétence du personnel aux fins des systèmes de certification figurent dans l'ISO 22712¹.

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;

¹ En cours d'élaboration. Stade au moment de la publication: ISO FDIS 22712:2022

- 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.

NOTE 105 La présente norme ne s'applique pas

- aux humidificateurs destinés à être utilisés avec des appareils de chauffage et de refroidissement (IEC 603352-88);
- aux appareils prévus exclusivement pour des usages industriels;
- aux appareils destinés à être utilisés dans des locaux présentant 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 est applicable 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 60079-14:2013, *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*

ISO 817, *Fluides frigorigènes – Désignation et classification de sûreté*

ISO 527-3, *Plastiques – Détermination des propriétés en traction – Partie 3: Conditions d'essai pour films et feuilles*

ISO 1302:2002², *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, *Climatiseurs et pompes à chaleur non raccordés – Essais et détermination des caractéristiques de performance*
ISO 5151:2017/AMD1:2020

ISO 7010:2019, *Symboles graphiques – Couleurs de sécurité et signaux de sécurité – Signaux de sécurité enregistrés*

ISO 13253, *Climatiseurs et pompes à chaleur air/air raccordés – Essais et détermination des caractéristiques de performance*

ISO 13256 (toutes les parties), *Pompes à chaleur à eau – Essais et détermination des caractéristiques de performance*

ISO 13355:2016, *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*

² Supprimée.

3 Termes et définitions

L'article de la Partie 1 est applicable 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, suivant la valeur la plus élevée.

3.1.9 Remplacement:

fonctionnement normal

conditions qui s'appliquent lorsque l'appareil est monté ou installé comme en usage normal et qu'il fonctionne dans les conditions les plus sévères spécifiées par le fabricant

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 frigorigère** 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 frigorifique** 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 évacué, 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 à la place de 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

dispositif de coupure 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 l'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 qui permet 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 condensation** 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 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. 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 plancher 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 maximale de fluide frigorigène** $m_{\max}$

charge maximale de fluide frigorigène 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 maximale de fluide frigorigène** 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 "auto ignition temperature".

[SOURCE: ISO 5149-1:2014, définition 3.7.7, modifié – "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 énumérées à l'Annexe BB.

Note 2 to entry: L'abréviation "LFL" est dérivée du terme anglais développé correspondant "lower flammability limit".

[SOURCE: ISO 817:2014, 3.1.24, modifié – "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 garantir un niveau élevé de confiance garantissant 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 Vide

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 Vide

3.148 Vide

3.149 Vide

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 Vide

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 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 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 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:

- les compresseurs;
- les pompes;
- les composants des systèmes scellés à absorption;
- les évaporateurs, dont chaque section individuelle a un volume contenant le fluide frigorigène de 15 litres au maximum;
- les serpentins;
- les tuyauteries et leurs robinets, les joints et les raccords;
- les dispositifs de commande; et
- les 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” 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 semi-conducteurs, 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.

4 Exigences générales

L'article de la Partie 1 est applicable.

5 Conditions générales d'essais

L'article de la Partie 1 est applicable 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 frigorigène**.*

NOTE 101 À titre de référence, les températures de la tuyauterie de fluide frigorigène peuvent être mesurées durant l'essai de l'Article 11.

*Si 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 les essais de l'Annexe LL sont effectués, des **capteurs de fluide frigorigène** supplémentaires sont nécessaires.*

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 paragraphes 19.104.2 à 19.104.8 peut être effectué dans n'importe quel ordre dans l'Article 19.

5.6 Addition:

Tous les dispositifs de réglage de température ou d'humidité de l'espace conditionné sont rendus inopérants durant 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 sévères 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 est applicable 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 vérification est effectuée par examen.

7 Marquage et instructions

L'article de la Partie 1 est applicable avec les exceptions suivantes.

7.1 Modification:

Remplacer le second tiret par:

- symbole pour la nature de l'alimentation qui comprend le nombre de phases, sauf pour le 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; si les **pressions maximales admissibles** différent 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**;
 - s'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.

Si 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 en 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) incluant 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.

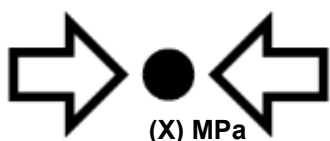
Si le type de fluide frigorigène n'est pas visible par l'**accès de service** (éventuellement fourni), l'**accès de service** doit porter un marquage d'identification du type de fluide frigorigène utilisé. Si le fluide frigorigène est inflammable, le symbole de l'ISO 7010-W021 (2011-05) qui comprend le groupe de sécurité selon l'ISO 817 doit être inclus, sans spécifier la couleur.

Si 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.

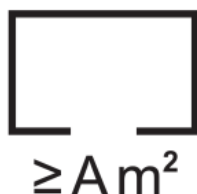
Les appareils qui ne sont pas des **appareils installés à poste fixe**, utilisant un **fluide frigorigène inflammable** avec une **charge de fluide frigorigène** (m_c) de l'appareil supérieure à m_1 conformément à GG.1.2, doivent porter le symbole de l'ISO 7000-0434A (2004-01) immédiatement suivi du symbole de surface minimale du local de l'IEC 60417-6412 (2019-03), où "A" est la surface minimale du local en m² 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'entretiengroupe 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:

- a) l'indication que l'appareil doit être installé conformément aux règles nationales d'installation électrique;
- b) les dimensions de l'espace nécessaire pour garantir une installation correcte de l'appareil, notamment les distances minimales admissibles par rapport aux structures adjacentes;
- c) pour les appareils équipés de **chauffe-air supplémentaires**, les distances dans l'air minimales entre l'appareil et les surfaces combustibles;
- d) un schéma de câblage avec une indication claire des connexions, du raccordement des dispositifs de commande externes et du **câble d'alimentation**;
- e) 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);
- f) la méthode de raccordement de l'appareil au réseau électrique et les liaisons entre les différents composants;
- g) l'indication des parties de l'appareil qui conviennent à une utilisation en extérieur, si applicable;
- h) l'indication du type et du calibre des fusibles, ou le calibre des disjoncteurs;

- i) les informations détaillées sur les éléments chauffants supplémentaires qui peuvent être utilisées en conjonction avec l'appareil, notamment les instructions de montage soit avec l'appareil soit avec le **dispositif de chauffage supplémentaire**;
- j) les températures de régime minimale et maximale de l'eau ou de la saumure;
- k) les pressions de régime minimale et maximale de l'eau ou de la saumure;
- 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 qui doit préciser que l'orifice de ventilation ne doit pas être obstrué.

7.12.101 Pour les **appareils non accessibles au public**, la classification selon 6.101 doit être incluse.

La vérification est effectuée par examen.

7.12.102 Pour les **appareils** qui utilisent des **fluides frigorigères inflammables**, un manuel d'installation, un manuel d'entretien de maintenance et de réparation, et un manuel de mise hors service (séparés ou combinés) doivent être mis à disposition et inclure les informations fournies à l'Annexe DD.

La vérification est effectuée par examen.

Des recommandations supplémentaires sur le transport, le marquage et le stockage des unités qui utilisent des **fluides frigorigères inflammables** sont données à l'Annexe CC.

7.15 *Addition:*

Un marquage peut être placé sur un panneau qui peut être retiré pour l'installation ou la maintenance, 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 remplaçables.

La vérification est effectuée par examen.

7.102 Si 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 vérification est effectuée par examen.

7.103 Pour les appareils constitués de plusieurs ensembles assemblés en usine à utiliser ensemble d'après les spécifications du fabricant, des instructions doivent être fournies pour construire l'ensemble conformément aux exigences établies.

La vérification est effectuée 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 garantissant que la pression de régime maximale est prise en considération 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 visant à garantir 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 concernant les **unités partielles**. Il faut uniquement raccorder l'unité 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 vérification est effectuée 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."

Si 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 vérification est effectuée 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."

Si 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 vérification est effectuée 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 vérification est effectuée 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 en 7.6, doit être visible sur l'emballage de l'appareil si celui-ci est chargé de fluide frigorigène.

La hauteur perpendiculaire du symbole doit être d'au moins 30 mm.

La vérification est effectuée par examen.

7.109 Les appareils qui utilisent 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 qui permettent 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 vérification est effectuée 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 qu'il faut débrancher l'appareil 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 portant 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;
- s'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 vérification est effectuée 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 vérification est effectuée par examen.

8 Protection contre l'accès aux parties actives

L'article de la Partie 1 est applicable avec l'exception suivante.

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 vérification est effectuée conformément au 5.10 (après installation conformément aux instructions d'installation).

9 Démarrage des appareils à moteur

L'article de la Partie 1 n'est pas applicable.

10 Puissance et courant

L'article de la Partie 1 est applicable.

11 Échauffements

L'article de la Partie 1 est applicable avec les exceptions suivantes.

11.1 Addition:

Si la température d'un enroulement de moteur dépasse la valeur spécifiée dans le Tableau 3 ou s'il existe un doute en ce qui concerne la classification du système d'isolation employé dans un moteur, la vérification est effectuée 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 tel que celui décrit en 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 comme cela est représenté à la Figure 102 a) ou 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 sorte 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, $(AB)^{0,5}$ comme cela est représenté à la Figure 102a ou la distance minimale spécifiée par le fabricant, la plus faible des deux étant retenue;
- pour les appareils à flux descendant, $300 + (AB)^{0,5}$ comme cela est représenté à la Figure 102 b) ou la distance minimale spécifiée par le fabricant, la plus faible des deux étant retenue.

NOTE 101 Pour les produits à conduits horizontaux, référence Figure 102b, tournés de 90 degrés 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 1 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 ft) moins la distance dans l'air spécifiée par rapport aux matériaux combustibles.

EXEMPLE 2 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 n'inclut pas de **chauffe-air supplémentaire** 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 individuelles à la température ambiante maximale spécifiée dans les instructions. Si 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 concernant 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 Caisson d'essai

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.

Si aucune distance dans l'air minimale n'est spécifiée pour l'installation de l'appareil, il faut envelopper étroitement l'appareil et le conduit de sortie 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 1^{er} alinéa et la NOTE 1 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'influence la 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 lorsqu'il s'agit de mesurer de petites parties telles que des composants électroniques.

11.3 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 par 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 Ce paragraphe de la Partie 1 n'est pas applicable.

11.6 Ce paragraphe de la Partie 1 n'est pas applicable.

11.7 Addition:

Si 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 selon cette formule:

$$\text{Limite de température [°C]} = 25 \text{ °C} + \text{valeur du Tableau 3} \quad (101)$$

NOTE 101 La formule (101) calcule la limite de température à partir de l'échauffement comme cela est défini dans le Tableau 3.

Tableau 3 – Échauffement normal maximal

Modification:

À la première ligne, remplacer "Enroulements" par "Enroulements autres que ceux des motocompresseurs hermétiques".

Addition:

Parties	Échauffement K
Enroulements de motocompresseurs hermétiques ^{aa}	
– avec une isolation synthétique	115
– avec une isolation non synthétique	105
Conduit et plénum de refoulement aux points de distances dans l'air égales à zéro spécifiés par rapport à l'enveloppe d'essai	67
^{aa} Non exigé pour les motocompresseurs qui satisfont à l'IEC 60335-2-34 (y compris son Annexe AA).	
NOTE 2 Addition:	
Les pompes à chaleur , les climatiseurs et autres appareils couverts par la présente norme peuvent avoir une température ambiante différente de celle des appareils domestiques normaux, par exemple certains produits sont utilisés à l'extérieur	

12 Vide

13 Courant de fuite et rigidité diélectrique à la température de régime

L'article de la Partie 1 est applicable avec l'exception suivante.

13.2 Modification:

Pour les **appareils fixes à moteur de la classe I**, le courant de fuite ne doit pas dépasser 3,5 mA, ou 2 mA par kilowatt de **puissance assignée**, la valeur la plus élevée étant retenue. La valeur maximale ne doit pas dépasser 10 mA pour les **appareils accessibles au public** et 30 mA pour les **appareils non accessibles au public**.

14 Surtensions transitoires

L'article de la Partie 1 est applicable.

15 Résistance à l'humidité

L'article de la Partie 1 est remplacé par le texte suivant.

15.1 Les composants électriques des appareils doivent être protégés contre la pénétration d'eau qui peut être présente dans l'appareil par suite de la pluie, du débordement du récipient de drainage ou du dégivrage.

La vérification est effectuée par les essais du 15.2, immédiatement suivis par l'essai de débordement du 15.3, puis de l'essai de dégivrage du 11.6 et des essais de l'Article 16.

Après ces essais, l'intérieur des enveloppes est examiné. L'eau susceptible d'avoir pénétré à l'intérieur de l'enveloppe ne doit pas entraîner une réduction des **distances dans l'air** et des **lignes de fuite** au-dessous des valeurs minimales spécifiées à l'Article 29.

Si des conduits menant à l'extérieur du bâtiment sont utilisés, les terminaisons de ces conduits sont soumises à l'essai du 15.2 dans un dispositif simulant l'installation réelle, conformément aux instructions fournies. Pour les appareils destinés à être installés à travers un mur ou une fenêtre ou pour les appareils split, l'essai du 15.2 est effectué sur la partie de l'unité qui est destinée à être installée à l'extérieur du bâtiment, conformément aux instructions.

*Le motocompresseur n'est pas mis en fonctionnement et les **parties amovibles** sont retirées pendant les essais du 15.2 et du 15.3.*

15.2 Les appareils autres que IPX0 sont soumis aux essais de l'IEC 60529:1989 comme suit:

- les appareils IPX1 comme cela est décrit en 14.2.1;
- les appareils IPX2 comme cela est décrit en 14.2.2;
- les appareils IPX3 comme cela est décrit en 14.2.3;
- les appareils IPX4 comme cela est décrit en 14.2.4;
- les appareils IPX5 comme cela est décrit en 14.2.5;
- les appareils IPX6 comme cela est décrit en 14.2.6;
- les appareils IPX7 comme cela est décrit en 14.2.7.

Pour l'essai IPX7, l'appareil est immergé dans de l'eau contenant 1 % de NaCl.

15.3 L'appareil est installé dans sa position d'usage normal. Le tuyau de refoulement du récipient de drainage est bouché, et le récipient de drainage rempli soigneusement à ras bord sans éclaboussure. Le récipient de drainage est ensuite soumis à un débordement continu dont le débit est réglé à approximativement 17 cm³/s par 1 m³/s de débit d'air. Le ou les ventilateurs sont mis en fonctionnement. L'essai se poursuit durant une durée de 30 min ou jusqu'à ce que toute l'eau s'écoule de l'appareil.

15.101 Essai de débordement

*Les appareils installés à l'intérieur, au sol ou au mur, et les **appareils accessibles au public** sont soumis aux essais de la manière suivante.*

L'appareil est installé conformément aux instructions d'installation, mais n'est pas mis en fonctionnement.

Les couvercles qui permettent d'accéder aux commandes électriques manuelles sont placés en position ouverte, à moins qu'ils ne soient à fermeture automatique.

*Une solution de 0,25 l d'eau qui contient environ 1 % de NaCl est déversée sur l'ensemble de manière qu'il puisse en résulter une pénétration d'eau dans ou sur des commandes électriques ou des **parties actives non isolées**.*

Lorsque le débordement est terminé, les appareils doivent satisfaire aux essais de l'Article 16.

L'essai de débordement n'est pas applicable aux unités si la dimension linéaire minimale de la surface supérieure horizontale ou pratiquement horizontale de l'enceinte est inférieure ou égale à 75 mm.

Il n'est pas nécessaire de soumettre aux essais une unité dont la hauteur est supérieure à 2 m.

NOTE L'objet de cet essai est de démontrer qu'un verre d'un diamètre de 75 mm ne peut pas être placé sur la surface de l'appareil et se renverser.

16 Courant de fuite et rigidité diélectrique

L'article de la Partie 1 est applicable avec l'exception suivante.

16.2 Modification:

*Pour les **appareils fixes à moteur de la classe I**, le courant de fuite ne doit pas dépasser 3,5 mA, ou 2 mA par kilowatt de **puissance assignée**, la valeur la plus élevée étant retenue. La valeur maximale ne doit pas dépasser 10 mA pour les **appareils accessibles au public** et 30 mA pour les **appareils non accessibles au public**.*

17 Protection contre la surcharge des transformateurs et des circuits associés

L'article de la Partie 1 est applicable.

18 Endurance

L'article de la Partie 1 n'est pas applicable.

19 Fonctionnement anormal

L'article de la Partie 1 est applicable avec les exceptions suivantes.

19.1 Modification:

Après le deuxième alinéa, ajouter ce qui suit:

Une défaillance affectant le débit du fluide de transfert ou le fonctionnement d'un dispositif de commande ne doit pas engendrer un danger.

Remplacer le premier et le deuxième alinéa de la spécification d'essai par ce qui suit:

Les appareils sont soumis aux essais spécifiés de 19.2 à 19.10, 19.101, 19.102, 19.103 et 19.104, le cas échéant.

19.2 Addition:

*Ce paragraphe de la Partie 1 n'est pas applicable aux appareils équipés de **chauffe-air supplémentaires**.*

19.3 Addition:

*Ce paragraphe de la Partie 1 n'est pas applicable aux appareils équipés de **chauffe-air supplémentaires**.*

19.4 Addition:

*L'appareil est mis en fonctionnement dans les conditions spécifiées à l'Article 11 et à la **tension assignée**, dans une condition de fonctionnement quelconque et avec tout défaut qui peut se présenter en usage normal. Une seule condition de défaut à la fois est reproduite, les essais étant réalisés l'un après l'autre.*

Des exemples de conditions de défaut sont:

- *l'arrêt de la minuterie, le cas échéant, sur une position quelconque;*
- *déconnexion et reconnexion d'une ou de plusieurs phases de l'alimentation;*
- *mise hors circuit ou en court-circuit de composants tels que les relais, contacteurs, minuteurs, **thermostats**, etc.*

En règle générale, les essais se limitent aux cas susceptibles de donner les résultats les plus défavorables.

19.7 Modification:

Remplacer le premier alinéa qui se termine par "... des autres appareils" par:

Les moteurs, autres que les motocompresseurs et les pompes de circulation fixes conformément à l'IEC 60335-2-51, sont installés sur un support de bois ou en matériau analogue. Les rotors des moteurs sont bloqués; les pales du ventilateur et les brides des moteurs ne sont pas enlevées.

*Les moteurs sont alimentés à leur tension d'alimentation lorsque l'appareil est alimenté à la **tension assignée** ou à la limite haute de la **plage assignée de tensions**, dans un circuit tel que celui représenté à la Figure 103. Il faut veiller à compléter le système de mise à la terre afin de permettre le fonctionnement correct du RCCB/RCBO.*

*Dans ces conditions, le moteur est mis en fonctionnement pendant 15 jours (360 h) ou jusqu'à ce qu'un **dispositif de protection** ouvre le circuit en permanence, selon la durée la plus courte des deux.*

Durant l'essai, la température ambiante est maintenue à $23\text{ °C} \pm 5\text{ °C}$.

Si la température des enroulements du moteur ne dépasse pas 90 °C lorsque les conditions de régime sont établies, l'essai est considéré comme terminé.

Durant l'essai, la température de l'enveloppe ne doit pas dépasser 150 °C et la température des enroulements ne doit pas dépasser les valeurs indiquées dans le Tableau 8.

Trois jours (72 h) après le début de l'essai, le moteur doit satisfaire à l'essai de rigidité diélectrique spécifié en 16.3.

*À la fin de l'essai, le courant de fuite mesuré selon 16.2, mais avec une tension d'essai égale à deux fois la **tension assignée** entre tous les enroulements et l'enveloppe ne doit pas dépasser 2 mA.*

NOTE 101 Seulement pour l'essai spécifié en 19.7 de l'IEC 60335-2-40, le moteur est bloqué et mis en fonctionnement pendant 15 jours (360 h) ou jusqu'à ce qu'un dispositif de protection ouvre le circuit en permanence. Il n'est pas prévu de répéter l'essai du rotor bloqué d'une durée de 15 jours deux fois de plus pour les moteurs comportant des condensateurs dans le circuit d'un enroulement auxiliaire. Par conséquent, pour tous les essais selon le 19.7 de la Partie 1, le moteur est mis en fonctionnement dans les conditions spécifiées en 19.7 de l'IEC 60335-1, y compris les spécifications de durée.

Après le dernier alinéa, ajouter ce qui suit:

Si le motocompresseur n'a pas été soumis aux essais de type selon les exigences de l'IEC 60335-2-34, il doit alors être soumis à l'essai suivant.

Un échantillon avec rotor bloqué doit être fourni, l'ensemble étant garni d'huile et de fluide frigorigène comme en usage prévu. L'échantillon doit alors être soumis aux essais spécifiés en 19.101, 19.102, 19.103 et 19.105 de l'IEC 60335-2-34:2021, le cas échéant, et doit satisfaire aux exigences du 19.104 de l'IEC 60335-2-34:2021.

19.8 Remplacement:

*Les moteurs triphasés autres que les motocompresseurs sont mis en fonctionnement dans les conditions spécifiées à l'Article 11, à la **tension assignée** ou à la limite haute de la **plage***

assignée de tensions, avec une phase déconnectée, jusqu'à l'établissement des conditions de régime ou que le **dispositif de protection** se déclenche.

19.9 Ce paragraphe de la Partie 1 n'est pas applicable aux motocompresseurs, aux pompes de circulation fixes conformes à l'IEC 60335-2-51 et aux ventilateurs.

19.11.4 *Modification:*

Avant le premier alinéa, ajouter ce qui suit:

Le premier alinéa de la Partie 1 n'est pas applicable si le fonctionnement non intentionnel n'entraîne aucun danger.

Remplacer le deuxième alinéa par ce qui suit:

*Les appareils comportant un **circuit électronique de protection** sont soumis aux essais du 19.11.4.1 au 19.11.4.7. Les essais sont effectués après le fonctionnement du **circuit électronique de protection** pendant les essais applicables de l'Article 19, à l'exception des 19.2, 19.6, 19.11.3, 19.102 et 19.103.*

*Si l'appareil comporte plusieurs **circuits électroniques de protection**, chaque **circuit électronique de protection** doit être soumis aux essais individuellement, l'appareil se trouvant dans les conditions de **fonctionnement normal** à une température comprise dans la plage de service.*

*Il n'est pas nécessaire de soumettre à l'essai dans l'application finale les composants protégés par un **circuit électronique de protection** qui ont déjà été soumis à des essais et dont la conformité aux exigences du 19.11.4 de la norme a été démontrée.*

NOTE 101 Les composants peuvent, par exemple, être des motocompresseurs, des ventilateurs et des pompes de circulation.

NOTE 102 Les résultats d'essai des 19.11.4.1, 19.11.4.2 et 19.11.4.3 peuvent être influencés par l'installation et le boîtier métallique de l'application finale. Par conséquent, il est préférable de réaliser ces essais après installation dans l'application finale.

NOTE 103 Le fonctionnement du **circuit électronique de protection** (PEC, Protective Electronic Circuit) est considéré comme l'action qui interrompt le fonctionnement du ou des composants, commandée par le PEC dans le but d'éviter toute situation dangereuse.

Après le dernier alinéa de la spécification d'essai, ajouter ce qui suit:

Il peut être nécessaire de fournir des échantillons de composants préparés spécialement pour ces essais, par exemple des compresseurs à rotor bloqué.

19.11.4.8 *Modification:*

Dans la première phrase, rajouter ce qui suit:

"à une température quelconque comprise dans la plage de service."

19.13 Modification:

Tableau 9 – Échauffement anormal maximal

Addition:

Partie	Échauffement K
Surfaces du produit, du plénum de refoulement et du conduit aux points de distances dans l'air égales à zéro spécifiés par rapport au caisson d'essai	150
Surfaces du caisson d'essai pour lesquelles une distance dans l'air supérieure à zéro par rapport aux matériaux combustibles est spécifiée	150

La Note a figurant au bas du Tableau 9 n'est pas applicable.

19.14 Modification:

Avant la note, ajouter:

Le blocage en position "marche" des contacts principaux d'un contacteur destiné à mettre en fonctionnement ou arrêter les éléments chauffants en usage normal est considéré comme une condition de défaut, sous réserve que l'appareil ne possède pas au moins deux systèmes de contacts raccordés en série. Par exemple, en installant deux contacteurs fonctionnant indépendamment l'un de l'autre ou en installant un contacteur avec deux armatures indépendantes agissant sur deux ensembles indépendants de contacts principaux.

19.101 L'appareil est mis en fonctionnement dans les conditions spécifiées à l'Article 11 à la **tension assignée** ou à la limite haute de la **plage assignée de tensions** et à une température ambiante de $23\text{ °C} \pm 5\text{ °C}$. Lorsque les conditions de régime sont établies, le débit du fluide de transfert de chaleur de l'**échangeur de chaleur extérieur** est réduit ou coupé, selon le cas le plus défavorable, sans que l'appareil ne soit rendu inopérant.

Après cet essai, les **dispositifs de protection** qui peuvent avoir fonctionné sont réarmés et l'essai est répété, mais en diminuant ou en coupant le débit du fluide de transfert de chaleur ou l'air de l'**échangeur de chaleur intérieur**, selon le cas le plus défavorable des deux, sans que l'appareil ne soit rendu inopérant. Dans le cas des appareils équipés d'un système de dégivrage, le débit du fluide de transfert de chaleur est également coupé au début de la phase de dégivrage.

Les appareils comportant un moteur unique pour les **échangeurs de chaleur intérieurs et extérieurs** sont soumis à l'essai ci-dessus, l'alimentation du moteur étant coupée lorsque les conditions de régime sont établies.

19.102 L'**échangeur de chaleur intérieur** des appareils qui utilisent l'eau comme fluide de transfert de chaleur est soumis à l'essai suivant.

L'appareil est mis en fonctionnement dans les conditions spécifiées à l'Article 10, à la **tension assignée** ou à la limite haute de la **plage assignée de tensions** avec la température d'eau maximale spécifiée par le fabricant. La température de l'eau du circuit intérieur doit être augmentée de 15 K à un débit de 2 K/min et cette température est maintenue pendant 30 min ensuite, la température de l'eau est ramenée à sa valeur initiale au même débit.

19.103 Les appareils air/air sont mis en fonctionnement dans les conditions spécifiées à l'Article 11.

La **température de bulbe sec** est alors ramenée à une valeur de 5 K au-dessous de la température minimale spécifiée par le fabricant.

L'essai est répété excepté que la **température de bulbe sec** est augmentée à une valeur de 10 K au-dessus de la température maximale spécifiée par le fabricant, mais sans dépasser 55 °C.

Les appareils sont mis en fonctionnement à la **tension assignée** ou à la limite haute de la **plage assignée de tensions**.

19.104 Appareils équipés de chauffe-air supplémentaires

19.104.1 Généralités

Les appareils équipés de **chauffe-air supplémentaires** ou les dispositions pour les **chauffe-air supplémentaires** sont soumis aux essais de 19.104.2 à 19.104.8 dans les conditions spécifiées à l'Article 11, sauf indication contraire.

Tous les appareils équipés de **chauffe-air supplémentaire** doivent être configurés avec des conduits d'entrée et de sortie, selon le cas, et instrumentés conformément aux paragraphes applicables de l'Article 11.

Les appareils sont soumis aux essais en **état de fonctionnement** et de configuration, ce qui donne les résultats les plus défavorables.

Les appareils fonctionnent à une température ambiante de $23\text{ °C} \pm 5\text{ °C}$ et à une **tension assignée** ou à la limite supérieure de la **plage assignée de tensions** du **chauffe-air supplémentaire**.

Les essais doivent être effectués avec tous les éléments chauffants du **chauffe-air supplémentaire** activés comme le permettent les commandes de l'unité, les thermostats étant neutralisés. Si les commandes de l'unité ne permettent pas d'activer tous les éléments chauffants du **chauffe-air supplémentaire** en neutralisant les thermostats, l'essai doit alors être effectué avec les thermostats neutralisés et la température de l'air réduite à une valeur qui déclenche l'activation de tous les éléments.

Pour les appareils équipés de **chauffe-air supplémentaire**, la chaleur fournie par la **pompe à chaleur** peut être simulée en utilisant une source de chauffage alternative égale à la capacité de la **pompe à chaleur** lorsqu'elle fonctionne dans les conditions prévues à l'Article 11. Si, au cours des essais du 19.104, le fonctionnement de la **pompe à chaleur** est interrompu par une commande de protection, la source de chaleur alternative doit être interrompue de la même manière.

19.104.2 Entrée restreinte – 1^{re} coupure limite

Pour réaliser l'essai dans les conditions de coupure limite, les conditions de débit d'air spécifiées sont établies, le débit d'air intérieur est réduit en limitant l'ouverture de l'air d'entrée à un taux résultant en un échauffement de l'air de sortie ne dépassant pas 1 K/min jusqu'à ce qu'un dispositif à **coupe-circuit thermique à réarmement automatique** fonctionne pour la première fois du fait d'une lente réduction de la zone libre de l'entrée.

La température de l'air de sortie, mesurée au moyen de la grille des thermocouples, ne doit pas dépasser 90 °C.

19.104.3 Entrée restreinte – débit d'air minimal

Pour réaliser l'essai dans les conditions de fonctionnement du chauffage, après l'établissement des conditions de débit d'air spécifiées, le débit d'air intérieur est réduit en limitant l'ouverture d'entrée d'air de sorte que la température de l'air dans la sortie d'air soit inférieure de 3 K à la température obtenue après qu'un dispositif à **coupe-circuit thermique à réarmement automatique** a fonctionné pour la première fois du fait d'une lente réduction de la zone libre de l'entrée.

L'appareil doit être mis en fonctionnement jusqu'à l'établissement des conditions de régime permanent ou pendant une heure, suivant la durée la plus longue des deux. Pendant l'essai, les températures sont surveillées en permanence et ne doivent pas dépasser les valeurs présentées dans le Tableau 3.

*Pour faciliter cet essai, le **coupe-circuit thermique à réarmement automatique** qui a fonctionné en 19.104.2 peut être court-circuité, au besoin.*

NOTE Les essais de 19.104.4 peuvent être effectués immédiatement après les essais de 19.104.2.

19.104.4 Entrée restreinte – entrée restreinte jusqu'au blocage complet

*Pour réaliser l'essai dans les conditions d'entrée réduite, après établissement des conditions de débit d'air spécifiées, le débit d'air intérieur est réduit en limitant l'ouverture de l'air d'entrée à un taux résultant en un échauffement de l'air de sortie ne dépassant pas 1 K/min jusqu'à ce qu'un dispositif de **coupe-circuit thermique à réarmement automatique** fonctionne.*

*La réduction doit être arrêtée après le fonctionnement de tout **dispositif de protection** jusqu'à ce que des conditions de régime permanent soient établies. Lorsque les conditions de régime permanent sont atteintes, la réduction est reprise. L'essai doit continuer jusqu'à ce que l'entrée soit complètement réduite.*

Les températures sont surveillées en permanence. Les températures ne doivent pas dépasser les valeurs présentées dans le (Tableau 3 + 30 K) pendant la première heure et dans le Tableau 3 par la suite.

19.104.5 Défaillance du ventilateur

Pour réaliser l'essai dans les conditions de défaillance des ventilateurs, après l'obtention des conditions de régime permanent, le débit du fluide de transfert de chaleur de l'échangeur de chaleur intérieur est réduit ou coupé, selon ce qui est le plus défavorable, sans mettre à l'arrêt l'appareil.

Les températures ne doivent pas dépasser les valeurs indiquées en 19.13.

19.104.6 Sortie bloquée

Pour réaliser l'essai dans les conditions de sortie bloquée, lorsque les conditions de régime sont atteintes, l'ouverture d'air de sortie de l'appareil est totalement fermée et le fonctionnement se poursuit jusqu'à ce que les températures maximales soient déterminées.

Cet essai avec l'ouverture de sortie d'air fermée ne doit pas être effectué sur un appareil dont les ouvertures de refoulement libre de l'air sont situées à plus de 1,2 m au-dessus du niveau du sol lorsque l'appareil est installé comme prévu.

Les températures ne doivent pas dépasser les valeurs indiquées en 19.13.

19.104.7 Barrière de tissu

Tous les appareils équipés de **chauffe-air supplémentaires** et avec des ouvertures de refoulement libre de l'air sont soumis à l'essai suivant dans chaque mode de fonctionnement.

Cet essai ne doit pas être effectué sur des appareils dont les ouvertures de refoulement libre de l'air sont situées à plus de 1,8 m au-dessus du niveau du sol lorsque celui-ci est installé comme prévu.

Les appareils sont mis en fonctionnement dans les conditions spécifiées à l'Article 11, en mettant en court-circuit les éventuelles commandes qui permettent de limiter la température durant l'essai de l'Article 11 et en recouvrant l'appareil.

Le recouvrement est réalisé au moyen de bandes de feutre d'une largeur de 100 mm et doublées d'une couche de tissu.

Le feutre a une masse spécifiée de $4 \text{ kg/m}^2 \pm 0,4 \text{ kg/m}^2$ et une épaisseur de 25 mm.

Le tissu est constitué d'une pièce de coton décati à ourlet double dont la masse à sec est comprise entre 140 g/m^2 et 175 g/m^2 .

Des thermocouples sont fixés au dos de petits disques noircis en cuivre ou en laiton de 15 mm de diamètre et de 1 mm d'épaisseur.

Les disques sont espacés de 50 mm et placés entre le tissu et le feutre sur l'axe vertical de chaque bande.

Les disques sont soutenus de façon à les empêcher de s'enfoncer dans le feutre.

Les bandes sont appliquées, le tissu étant en contact avec l'appareil, de façon à couvrir totalement la surface frontale, à passer par-dessus le bord supérieur et à s'étendre jusqu'au bas de la surface arrière.

Si l'appareil est construit pour être installé à distance du mur ou pour être fixé à un mur de manière que l'espace entre l'appareil et le mur soit supérieur à 30 mm et que la projection horizontale de la distance entre deux points de fixation ou butées, ou entre de tels points et l'extrémité de l'appareil, soit supérieure à 100 mm, la surface arrière de l'appareil doit être complètement recouverte.

Dans le cas contraire, la face arrière est recouverte sur environ le cinquième de la hauteur de l'appareil.

Les bandes sont appliquées successivement sur chaque moitié de l'appareil puis sur l'appareil tout entier.

Durant l'essai, la température ne doit pas dépasser 150°C , mais un dépassement de 25 K est admis au cours de la première heure.

Les **dispositifs de protection** thermiques peuvent fonctionner.

19.104.8 Essai de protection de secours

Si un **coupe-circuit thermique à réarmement automatique** fonctionne pendant les essais de 19.104, il doit alors être contourné et les essais de 19.104.4 à 19.104.7 doivent être répétés.

Pour l'essai de 19.104.4, le taux de réduction doit être tel que l'ouverture soit totalement bloquée au bout de 30 minutes.

Les températures ne doivent pas dépasser les valeurs indiquées en 19.13.

19.105 Pour les **déshumidificateurs** dans lesquels le compresseur est enfermé dans une enveloppe en matériau non métallique qui l'isole du flux d'air forcé fournissant l'air à l'échangeur de chaleur, l'essai suivant doit s'appliquer.

L'essai doit être effectué dans chacune des conditions suivantes:

- avec 75 % de la charge supprimée;
- avec une pression du système inférieure à 0,12 MPa, mais pas inférieure à 0,10 MPa lorsque l'appareil est hors tension.

*L'appareil doit fonctionner dans les conditions prévues à l'Article 11, à la limite inférieure de la **plage assignée de tensions** et à une température ambiante de $23\text{ °C} \pm 5\text{ °C}$. L'appareil doit fonctionner jusqu'à ce que tous les composants et les températures de l'enceinte se stabilisent ou diminuent, mais pas moins de 24 heures, ou jusqu'à ce que le fonctionnement du compresseur soit interrompu par un **dispositif de protection** sans réarmement automatique. Tout **dispositif de protection** à réarmement automatique qui se déclenche au cours de cet essai doit être autorisé à effectuer un cycle comme prévu.*

Les températures des parties non métalliques ne doivent pas dépasser l'indice thermique relatif du matériau conformément à l'IEC 60695-1-10.

La vérification est effectuée par un essai.

20 Stabilité et dangers mécaniques

L'article de la Partie 1 est applicable avec l'exception suivante.

20.1 Addition:

Les **appareils installés à poste fixe** qui ne sont uniquement fixés en position par de la tuyauterie d'eau, de fluide frigorigène ou par d'autres tuyauteries sont également soumis à cet essai.

Ces tuyaux ne sont pas raccordés à l'appareil pendant cet essai.

21 Résistance mécanique

L'article de la Partie 1 est applicable avec les exceptions suivantes.

21.1 Addition:

Les **réipients sous pression** doivent être conformes aux exigences de l'ISO 5149-2:2014, 4.4.2.

L'essai de pression de l'Annexe EE s'applique aux parties autres que les **réipients sous pression**.

21.2 Modification:

Ajouter la phrase suivante après le deuxième alinéa:

*Pour les parties **accessibles en mousse de particules** utilisées comme **isolation supplémentaire** ou comme **isolation renforcée**, l'essai suivant est effectué sans prendre en considération l'épaisseur de l'isolation.*

21.101 Les appareils qui utilisent des **fluides frigorigènes inflammables** doivent supporter les effets des vibrations lors du transport.

L'appareil est soumis aux essais dans son emballage de transport final, fixé sur la table de vibration, et doit résister à un essai de vibrations aléatoires pendant 180 min conformément à l'ISO 13355:2016 avec le profil de densité spectrale de puissance spécifié dans le Tableau 101.

Tableau 101 – Profil de densité spectrale de puissance pour l'essai de vibration

Fréquence Hz	Niveau (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
Les valeurs intermédiaires doivent être interpolées comme cela est représenté à la Figure 104.	
NOTE La valeur efficace est de 5,1 m/s ² .	

Lorsque les essais conformes à l'ISO 13355:2016 ne sont pas réalisables en raison de la disponibilité limitée des installations/équipements d'essai dans l'industrie, l'appareil doit être soumis aux essais par un essai de transport représentatif du mode d'expédition tel que le camion, le train, l'avion et/ou l'expédition maritime. L'essai de transport par camion est obligatoire. Les essais de transport ferroviaire, aérien et/ou maritime sont facultatifs.

Le produit doit être transporté sur une distance non inférieure à deux fois l'itinéraire de transport le plus long prévu, déterminé par le fabricant en fonction du marché et de la distribution du produit. Quant au transport par camion, au moins 3 catégories de routes doivent être utilisées, représentant l'itinéraire de transport prévu avec au moins 10 % de la distance totale pour chaque catégorie de route.

La vérification est effectuée par ce qui suit:

- l'utilisation d'un appareil de détection dont la sensibilité équivalente est de 3 g/an de fluide frigorigène ne doit révéler aucune fuite;
- l'endommagement de parties autres que le circuit frigorifique est admis.

NOTE L'essai peut être effectué sur l'appareil chargé d'un fluide frigorigène non inflammable ou d'un gaz non dangereux lorsqu'il est pressurisé à la pression de vapeur saturée correspondant à une température de 23 °C.

22 Construction

L'article de la Partie 1 est applicable avec les exceptions suivantes.

22.6 Addition:

L'isolation électrique ne doit pas être affectée par de la neige pouvant pénétrer dans l'enveloppe de l'appareil.

22.14 Addition:

Cette exigence ne s'applique pas aux ailettes métalliques des **échangeurs de chaleur**.

22.24 Remplacement:

Les éléments chauffants nus doivent être supportés de sorte qu'en cas de rupture ou d'affaissement, le conducteur chauffant ne puisse pas entrer en contact avec des parties métalliques accessibles ni engendrer un danger. Les éléments chauffants nus ne doivent pas être utilisés avec des enveloppes en bois ou en composite.

La vérification est effectuée par examen et, au besoin, en coupant l'élément à l'endroit le plus défavorable. Aucune force ne doit être appliquée sur le conducteur après avoir été coupé.

Cet essai doit être effectué après les essais de l'Article 29.

22.46 Modification:

Après le premier alinéa, ajouter ce qui suit:

Si le logiciel du **circuit électronique de protection** fait partie du dispositif de commande en **fonctionnement normal**, l'examen du logiciel doit se limiter au code source approprié des commandes de sécurité ou des commandes logicielles associées.

22.101 Les appareils destinés à être fixés doivent être conçus de façon qu'ils puissent être fixés et maintenus en position de manière sûre.

La vérification est effectuée par examen et, en cas de doute, après installation de l'appareil conformément aux instructions d'installation.

22.102 Appareils équipés de dispositifs de chauffage supplémentaires

22.102.1 Les appareils équipés de **chauffe-air supplémentaires** doivent comporter au moins deux **coupe-circuit thermiques**. Le **coupe-circuit thermique** prévu pour fonctionner le premier doit être un **coupe-circuit thermique à réarmement automatique** ou un **coupe-circuit thermique sans réarmement automatique**; l'autre doit être un **coupe-circuit thermique sans réarmement automatique**.

La vérification est effectuée par examen et par les essais de l'Article 19.

22.102.2 Les appareils équipés de **chauffe-eau supplémentaires** doivent incorporer un **coupe-circuit thermique sans réarmement automatique** fournissant une **coupure omnipolaire**, qui fonctionne indépendamment des **thermostats** utilisés pour l'eau. Cependant, pour les appareils destinés à être raccordés à des canalisations fixes, il n'est pas nécessaire de déconnecter le conducteur neutre.

La vérification est effectuée par examen et par les essais de l'Article 19.

NOTE Les dispositifs de chauffage antigel ne sont pas considérés comme des **chauffe-eau supplémentaires**. S'il n'est pas possible de chauffer l'eau à une température supérieure à 80 °C à la température de régime la plus élevée sur une durée de 6 h, l'interrupteur de température étant en court-circuit et le débit d'eau interrompu.

22.102.3 Les **coupe-circuit thermiques** de type capillaire doivent être conçus de sorte que les contacts s'ouvrent en cas de fuite en dehors du tube capillaire.

La vérification est effectuée par examen et par essai.

22.103 Les éléments de détection et de coupure des coupe-circuit électromécaniques sans réarmement automatique doivent être fonctionnellement indépendants des autres dispositifs de commande. Si l'élément de coupure d'un coupe-circuit sans réarmement automatique commande un relais ou un contacteur, le relais ou le contacteur peut également être mis en fonctionnement par d'autres dispositifs de commande. Les **circuits électroniques de protection** sont couverts par l'Article 19.

La vérification est effectuée par examen.

22.104 Les réservoirs des **pompes à chaleur pour l'eau chaude sanitaire** doivent résister à la pression d'eau habituellement rencontrée en usage normal.

*La vérification est effectuée en soumettant les réservoirs et les **échangeurs de chaleur** (s'ils existent) à une pression d'eau qui est élevée jusqu'à la valeur spécifiée ci-dessous à une vitesse de 0,13 MPa par seconde et qui est maintenue à cette valeur pendant 5 min.*

La pression d'eau est égale à:

- *deux fois la **pression maximale admissible** pour les réservoirs fermés;*
- *0,15 MPa pour les réservoirs ouverts.*

Après l'essai, aucune fuite d'eau ne doit être observée et les réservoirs ne doivent pas s'être rompus.

NOTE Si le réservoir des **pompes à chaleur pour production d'eau chaude sanitaire** incorpore un **échangeur de chaleur**, le réservoir et l'**échangeur de chaleur** sont soumis à l'essai de pression conformément à la norme applicable.

22.105 Dans le cas de réservoirs fermés pour les **pompes à chaleur pour production d'eau chaude sanitaire**, la formation d'un coussin d'air ou de vapeur de plus de 2 % de la capacité, sans dépasser 10 %, doit être assurée.

La vérification est effectuée par examen et, au besoin, par des mesurages.

22.106 Les **dispositifs de coupure de pression**, qu'ils soient incorporés au réservoir des **pompes à chaleur pour production d'eau chaude sanitaire** ou fournis séparément, doivent empêcher la pression présente à l'intérieur du réservoir de dépasser la **pression maximale admissible** de plus de 0,1 MPa.

La vérification est effectuée en soumettant le réservoir à une augmentation progressive de la pression d'eau et en observant la pression à laquelle le dispositif de coupure se met en fonctionnement.

22.107 Les tubulures de sortie des réservoirs ouverts des **pompes à chaleur pour production d'eau chaude sanitaire** doivent être libres de tout obstacle susceptible de limiter le débit d'eau de façon que la pression à l'intérieur du réservoir dépasse la **pression maximale admissible**.

Les réservoirs à l'air libre des **pompes à chaleur pour production d'eau chaude sanitaire** doivent être construits de sorte que le réservoir soit toujours en relation avec l'atmosphère par une ouverture d'au moins 5 mm de diamètre ou de 20 mm² de surface, avec une hauteur libre d'au moins 3 mm.

La vérification est effectuée par examen et par mesurage.

NOTE La première exigence est réputée satisfaite si la surface de l'orifice de sortie de l'eau à partir de la partie chauffée du réservoir de la **pompe à chaleur pour production d'eau chaude sanitaire** est supérieure ou égale à la surface de l'orifice d'entrée de l'eau vers la partie chauffée.

22.108 Les réservoirs ouverts des **pompes à chaleur pour production d'eau chaude sanitaire** doivent résister aux surpressions accidentelles qui peuvent se produire en usage normal.

La vérification est effectuée en soumettant les réservoirs qui ne sont pas à l'air libre au 22.104 à une dépression de 33 kPa pendant 15 min.

Après l'essai, l'appareil ne doit présenter aucune déformation pouvant être dangereuse.

Si des vannes antidépression sont présentes, celles-ci sont rendues inopérantes.

NOTE Cet essai peut être effectué sur des réservoirs séparés.

22.109 Le câblage connecté à un **coupe-circuit thermique sans réarmement automatique** destiné à être remplacé après son fonctionnement doit être sécurisé de sorte que le remplacement du **coupe-circuit thermique** lui-même ou d'un élément chauffant sur lequel est monté le **coupe-circuit thermique** n'endommage pas les autres connexions ni le câblage intérieur.

La vérification est effectuée par examen et, au besoin, par un essai à la main.

22.110 Les **coupe-circuit thermiques sans réarmement automatique** destinés à être remplacés après leur fonctionnement doivent ouvrir le circuit de la façon prévue, sans mettre en court-circuit les **parties actives** de potentiels différents et sans que les **parties actives** n'entrent en contact avec l'enveloppe.

La vérification est effectuée par l'essai suivant.

L'appareil est mis en fonctionnement cinq fois, chaque fois avec un nouveau coupe-circuit thermique sans réarmement automatique, tous les autres dispositifs de commande thermiques étant en court-circuit.

*Le **coupe-circuit thermique** doit fonctionner comme prévu à chaque fois.*

Durant l'essai, l'enveloppe de l'appareil est mise à la terre au moyen d'un fusible de 3 A; ce fusible ne doit pas griller.

Après cet essai, les éléments chauffants supplémentaires doivent satisfaire à l'essai de rigidité diélectrique spécifié en 16.3.

22.112 La construction du système frigorifique doit satisfaire aux exigences de l'ISO 5149-2:2014, paragraphes 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, et 5.2.9.4. et de l'ISO 5149-2:2014/AMD1:2020, paragraphes 4.1, 5.2.3, 5.2.9.2.

NOTE Une **vanne d'arrêt de sécurité** est un robinet d'isolement au sens de l'ISO 5149-2.

La vérification est effectuée par examen.

22.113 Lorsqu'un **fluide frigorigène inflammable** est utilisé, la tuyauterie de fluide frigorigène doivent être protégés ou enfermés pour éviter tout dommage mécanique. La tuyauterie de fluide frigorigène doivent être protégés de manière à ne pas être manipulés ou utilisés pour le transport lors des déplacements de l'appareil. La tuyauterie de fluide frigorigène situés dans l'enceinte de l'appareil sont considérés comme étant protégés contre les dommages mécaniques.

La vérification est effectuée par examen.

22.114 Lorsqu'un **fluide frigorigène inflammable** est utilisé, des alliages de brasage à basse température (comme les alliages plomb/étain) ne doivent pas être utilisés pour les raccordements des tuyaux ou tout autre fluide frigorigène sous pression.

La vérification est effectuée par examen.

22.115 La **charge de fluide frigorigène** (m_c) dans chaque **système frigorifique** qui utilise du **fluide frigorigène inflammable** ne doit pas dépasser la valeur m_3 définie à l'Annexe GG.

La construction du **système frigorifique** qui utilise des **fluides frigorigènes inflammables** doit satisfaire aux exigences de l'Annexe GG.

La vérification est effectuée par examen.

22.116 Arcs et étincelles des composants électriques

22.116.1 La construction des appareils qui utilisent des **fluides frigorigènes inflammables** doit être telle que tout fluide frigorigène qui a fui ne s'étende pas ou ne stagne pas de manière à présenter un risque d'incendie ou d'explosion à l'intérieur de l'appareil ou des conduits raccordés où sont situés les composants électriques, qui peuvent constituer une source d'inflammation et qui peuvent fonctionner pendant le **fonctionnement normal** ou en cas de fuite.

NOTE Les coupe-circuit thermiques et les dispositifs similaires ne sont pas considérés comme fonctionnant pendant le **fonctionnement normal**.

Des composants distincts, tels que des **thermostats**, chargés avec moins de 0,5 g de gaz inflammable ne sont pas considérés comme étant susceptibles de présenter un risque d'incendie ou d'explosion en cas de fuite du gaz à l'intérieur même du composant.

*Les composants électriques, qui sont des sources d'inflammation potentielles et qui peuvent fonctionner dans le cadre d'un **fonctionnement normal** ou par suite d'une fuite, ne sont pas considérés comme une source d'inflammation s'ils sont conformes à au moins une des exigences suivantes:*

- a) *ne se trouvent pas dans une zone, où un mélange de gaz potentiellement inflammables s'accumule, comme cela est démontré par l'essai de l'Annexe FF;*
- b) *ont un niveau de protection du matériel conforme au 22.116.2;*
- c) *sont des composants scellés conformes aux essais de 22.116.3, et sont protégés des chocs par l'enveloppe de l'appareil;*
- d) *se trouvent dans une enveloppe conforme à l'IEC 60079-10:2017 Articles 7 à 10 concernant les enveloppes à respiration limitée adaptées à une utilisation avec des gaz du groupe IIA ou le fluide frigorigène utilisé;*
- e) *sont situés dans une enveloppe conforme à l'Annexe NN. Applicable uniquement aux appareils qui utilisent des **fluides frigorigènes A2L**;*
- f) *sont conformes à l'Annexe JJ. Applicable uniquement aux appareils qui utilisent des **fluides frigorigènes A2L**;*
- g) *sont conformes au 22.116.4. Applicable uniquement aux appareils qui utilisent des **fluides frigorigènes A2L**;*
- h) *les purificateurs d'air électrostatiques ou dispositifs similaires soumis à l'essai et jugés conformes au 22.116.5. Applicable uniquement aux appareils qui utilisent des **fluides frigorigènes A2L**;*
- i) *les **capteurs de fluide frigorigène** soumis à l'essai et jugés conformes à l'Article LL.11.*

22.116.2 Les composants ne sont pas considérés comme des sources d'inflammation s'ils sont conformes aux exigences du Niveau de protection du matériel Ga, Gb ou Gc défini dans l'IEC 60079-14 pour les fluides frigorigènes utilisés dans l'appareil ou le groupe de gaz pertinent (IIA, IIB ou IIC) auquel appartient le fluide frigorigène. Toutefois, les exigences suivantes ne s'appliquent pas:

- les exigences de marquage de la norme applicable dans la série IEC 60079 (toutes les parties);
- les essais de choc de l'IEC 60079-0;
- l'essai IP de l'IEC 60079-0;
- l'essai de chute de l'IEC 60079-0;
- les exigences de ligne de fuite et de **distance dans l'air** de l'IEC 60079-7.

NOTE 1 La plupart des fluides frigorigènes appartiennent aux gaz du groupe IIA, mais le R-E170 appartient aux gaz du groupe IIB.

NOTE 2 Des exemples de principes de protection pertinents qui peuvent être appliqués sont:

- Les composants non-propagateurs de flamme "nC" dans l'IEC 60079-15:2017.
- Antidéflagrant "dc" dans l'IEC 60079-1:2014 (anciennement, dispositif de coupure enfermé "nC" dans l'IEC 60079-15:2010).
- Sécurité augmentée "ec" dans l'IEC 60079-7:2015/AMD1:2017 (anciennement, appareil basse puissance ne produisant pas d'étincelles "nA" dans l'IEC 60079-15:2010).
- Sécurité intrinsèque "ic" dans l'IEC 60079-11:2011 (anciennement, appareil à énergie limitée "nL" dans l'IEC 60079-15:2010).
- Les dispositifs clos "nC" dans l'IEC 60079-15:2017.
- Les dispositifs hermétiquement clos "nC" dans l'IEC 60079-15:2017.
- Les enveloppes à respiration limitée "nR" dans l'IEC 60079-15:2017.

La vérification est effectuée par examen ou par essai comme l'exige la norme pertinente de la série IEC 60079.

22.116.3 *Trois échantillons du composant doivent être conditionnés dans une chambre climatique pendant 168 h à la température maximale de régime pendant l'essai de l'Article 11 plus 12 K, mais pas moins de 75 °C. Ce conditionnement est suivi de 24 h à la température minimale de régime pendant l'essai de l'Article 11 réduite d'au moins 5 K.*

La température d'essai dans la chambre climatique doit être maintenue à 2 K pendant toute la durée de l'essai.

Les composants doivent être stabilisés à une température de 25 °C. L'ensemble des composants doit ensuite être rapidement immergé dans de l'eau à une température de (50 ± 2) °C, à une profondeur d'au moins 25 mm sous la surface, pendant au moins 60 secondes.

Aucune bulle ne doit sortir de l'intérieur des échantillons pendant cet essai.

22.116.4 Pour les **fluides frigorigènes A2L**, les dispositifs capables d'effectuer 100 000 cycles selon l'Article 24 en commutant des charges en courant alternatif conformément à l'un des points suivants ne sont pas considérés comme une source d'inflammation potentielle:

- pour les charges résistives dont l'impédance a un facteur de puissance supérieur à 0,99: Le courant de coupure par contact n'est pas supérieur à 48 A en **fonctionnement normal**.
- pour les charges inductives dont le facteur de puissance n'est pas supérieur à 0,99, la puissance apparente (S) de la charge électrique inductive commutée par phase en kVA est inférieure ou égale à:

- $L_e = 5 \times (6,7/S_u)^4$ en cas de coupure de toutes les phases d'une charge triphasée;
- $L_e = 2,5 \times (6,7/S_u)^4$ pour toutes les autres.

où

L_e est la puissance apparente maximale admise de la charge électrique inductive commutée en kilovoltampères (kVA),

S_u est la vitesse de combustion d'un fluide frigorigène en centimètres par seconde (cm/s).

La vérification est effectuée par des mesurages.

22.116.5 Les appareils qui utilisent des **fluides frigorigènes A2L**, les purificateurs d'air électrostatiques et appareils analogues qui peuvent produire des arcs électriques en **fonctionnement normal** et qui peuvent enflammer le fluide frigorigène utilisé, et qui sont installés dans le débit d'air ou les conduits de raccordement de l'unité, ne sont pas considérés comme étant une source d'inflammation potentielle si le débit d'air est surveillé et que la source d'énergie de l'arc électrique est coupée lorsque le débit d'air est inférieur au débit d'air minimal conformément à l'Article GG.9.

La vérification est effectuée par examen et, au besoin, par un essai approprié.

22.116.6 Aux fins de la détermination du diamètre de coincement maximal (d_q) de l'Annexe JJ et de la charge électrique inductive commutée maximale L_e (voir 22.116.4) l'effet de l'humidité sur la vitesse de combustion (S_u) doit être prise en considération.

La vitesse de combustion (S_u) doit être la plus élevée des valeurs suivantes:

- valeur spécifiée dans l'ISO 817; ou
- valeur mesurée dans l'air humide au point de rosée de $27\text{ °C} \pm 0,5\text{ °C}$ à 101,3 kPa qui contient $21,0\% \pm 0,1\%$ d'oxygène, en excluant la vapeur d'eau déterminée à la composition nominale spécifiée dans l'ISO 817.

NOTE Le point de rosée de 27 °C équivaut à une humidité absolue de 0,022 7 kg de vapeur d'eau pour 1 kg d'air sec.

Cet essai peut être réalisé à une température supérieure à 27 °C . Le point de rosée exigé ne concerne que l'humidité.

La vitesse de combustion (S_u) au point de rosée de 27 °C peut être déterminée par extrapolation de mesure à une température de 23 °C et une humidité relative de 50 % et de la vitesse de combustion (S_u) spécifiée dans l'ISO 817. L'extrapolation doit être fondée sur la valeur mesurée à laquelle s'ajoute l'incertitude de mesure de la vitesse de combustion (S_u) à une température de 23 °C et une humidité relative de 50 %. Si la vitesse de combustion (S_u) n'est pas mesurable à sec, elle doit être mesurée au point de rosée de 27 °C .

22.117 Surfaces brûlantes

22.117.1 Les températures sur les surfaces susceptibles d'être exposées à des fuites de **fluide frigorigène inflammable** supérieures à 25 % de la **LFL** telles qu'elles sont déterminées à l'Annexe FF ne doivent pas dépasser la température de surface maximale admissible spécifiée à l'Annexe BB.

Pour les fluides frigorigènes A2 et A3 qui ne sont pas répertoriés à l'Annexe BB, la température de surface maximale admissible est la **température d'autoinflammation**.

Pour les **fluides frigorigènes A2L** qui ne sont pas répertoriés à l'Annexe BB, la température de surface maximale admissible est déterminée par la température de surface maximale de la **température d'autoinflammation** ou, si elle est soumise à l'essai selon l'Annexe KK, par la **température d'inflammation des surfaces brûlantes** réduite de 100 K.

*La vérification est effectuée en mesurant les températures de surface appropriées au cours des essais des Articles 11 et 19 à l'exception des cas qui se terminent sans réarmement automatique lors des essais de l'Article 19. La vérification des **fluides frigorigènes A2L** est effectuée en mesurant les températures de surface appropriées au cours des essais de l'Article 11.*

Les surfaces conformes au 22.117 ne doivent pas être considérées comme une source d'inflammation potentielle.

Les **capteurs de fluide frigorigène** soumis à l'essai et jugés conformes à l'Article LL.11. sont jugés conformes au 22.117.

22.117.2 Les températures relevées sur les surfaces susceptibles d'être exposées à des fuites de **fluide frigorigène A2L** peuvent dépasser la température de surface maximale admissible en cas de perte de débit d'air lorsque l'ensemble des conditions suivantes s'appliquent:

- les températures ne dépassent pas la température de surface maximale admissible avec le débit d'air minimal;
- le débit d'air est surveillé et la source de chaleur de la surface chaude est coupée lorsque le débit d'air est inférieur au débit d'air minimal.

NOTE La preuve du débit d'air peut être fournie par tout moyen fiable, y compris la détection de la vitesse du ventilateur.

La vérification est effectuée par examen et en mesurant les températures de surface appropriées au cours des essais de l'Article 11.

22.117.3 Les sources d'inflammation ouvertes, notamment les flammes nues, les flammes pilotes, l'allumage direct par étincelle ou par surface chaude, ou toute autre source d'inflammation analogue dans le débit d'air de combustion, si l'air de combustion est prélevé à partir d'un endroit non ventilé où le fluide frigorigène qui fuit peut pénétrer par l'entrée d'air de combustion sont permises, sous réserve que ces appareils soient équipés d'un dispositif arrête-flammes ou équivalent empêchant la flamme de se propager en cas d'inflammation.

La vérification est effectuée par examen.

22.118 Les raccords mis en œuvre dans l'installation entre les parties du **système frigorifique**, avec au moins une partie chargée, doivent être réalisés comme suit.

- Un raccordement brasé, soudé ou mécanique doit être réalisé avant l'ouverture des vannes pour permettre au fluide frigorigène de s'écouler entre les parties du **système frigorifique**. Une vanne de dépression doit être prévue pour vidanger le tuyau de raccordement et/ou toute partie non chargée du **système frigorifique**.
- Les connecteurs mécaniques utilisés à l'intérieur doivent satisfaire à l'ISO 14903. Lorsque des connecteurs mécaniques sont réutilisés à l'intérieur, les parties d'étanchéité doivent être renouvelées. Lorsque des joints mandrinés sont réutilisés à l'intérieur, la partie mandrinée doit être réusinée.
- Les tuyaux de fluide frigorigène doivent être protégés ou placés sous enveloppe pour éviter tout dommage.

Les connecteurs souples de fluide frigorigène (comme les conduites entre l'unité intérieure et l'unité extérieure) qui peuvent être déplacés en **fonctionnement normal** doivent être protégés contre les dommages mécaniques.

La vérification est effectuée conformément aux instructions d'installation, et au besoin dans le cadre d'une installation d'essai.

22.119 Les **unités de condensation** et les **unités d'évaporation** doivent être équipées d'un **dispositif limiteur de pression** ou équivalent pour garantir que l'équipement ne dépasse pas la pression maximale admissible.

NOTE Cette exigence s'applique uniquement aux types d'**unités partielles**, aux **unités de condensation** et aux **unités d'évaporation**.

Pour les **unités partielles**, les circuits d'interconnexion pour la communication du signal entre chaque unité doivent être du même type.

Une connexion de niveau **TBTS** est recommandée.

La vérification est effectuée par examen.

22.120 Les **unités partielles** doivent être équipées d'un dispositif de connexion au réseau d'alimentation et ne doivent pas être alimentées par le circuit électrique d'un autre appareil.

La vérification est effectuée par examen.

22.121 Emplacement des capteurs du système de détection des fuites

22.121.1 Pour les conditions d'installation des appareils qui utilisent un **fluide frigorigène A2L** et lorsqu'un **système de détection des fuites** est appliqué pour satisfaire aux exigences de l'Annexe GG, ou dans le but de limiter la **charge libérable**, le **capteur de fluide frigorigène** doit être:

- à l'intérieur de l'unité pour les appareils reliés par un système de conduits d'air à un ou plusieurs locaux;
- dans l'enveloppe ventilée si elle est conforme à l'Article GG.4;
- à l'intérieur de l'unité lorsque la hauteur de sortie h_0 déterminée à l'Article GG.2 ne dépasse pas 1,5 m;
- lorsque la hauteur de sortie h_0 déterminée à l'Article GG.2 est supérieure à 1,5 m, le **capteur de fluide frigorigène** peut être situé à l'intérieur
 - de l'unité, ou à
 - 100 mm ou moins immédiatement sous l'unité, ou
 - à moins de 300 mm au-dessus du plancher. Si un **capteur de fluide frigorigène** distant est spécifié par le fabricant, les instructions doivent indiquer que le **capteur de fluide frigorigène** doit être situé à
 - i) une distance horizontale de 10 m avec visibilité directe sur l'unité et sur un mur à l'intérieur du local où est installée l'unité, ou
 - ii) à une distance de 7 m sans visibilité directe sur l'unité et sur un mur à l'intérieur du local où est installée l'unité. La distance entre l'unité et le **capteur de fluide frigorigène** doit être mesurée comme la distance horizontale non obstruée la plus courte entre l'unité et le **capteur de fluide frigorigène** le plus proche.

Pour les installations comportant des joints mécaniques installés sur place qui sont exposés dans l'espace occupé, les instructions doivent indiquer que le **capteur de fluide frigorigène** doit être situé:

- à une distance horizontale de 2 m avec visibilité directe sur l'unité et sur un mur à l'intérieur du local dans lequel est installée l'unité, et
 - à 100 mm au-dessus du plancher lorsque h_0 n'est pas à plus de 300 mm du plancher, ou
 - à 300 mm au-dessus du plancher lorsque h_0 est à plus de 300 mm du plancher.

Les joints mécaniques suivants ne doivent pas exiger l'emploi d'un tel **capteur de fluide frigorigène**:

- joints mécaniques conformes à l'ISO 14903;
- les joints figurant dans les enveloppes qui ventilent vers l'unité ou à l'extérieur;
- les joints figurant dans les enveloppes qui évacuent vers un local dont la surface minimale est spécifiée en GG.2.1.

NOTE 1 Un **capteur de fluide frigorigène** unique peut être utilisé s'il satisfait à l'ensemble des exigences de l'unité et des joints installés sur place.

NOTE 2 Il peut être nécessaire d'installer plusieurs **capteurs de fluide frigorigène** à différents endroits pour que l'appareil soit conforme à la présente norme.

*La vérification est effectuée par examen et en procédant aux essais conformément à l'Annexe MM ou à l'Annexe PP. Il n'est pas exigé de procéder à des essais conformément aux Annexes MM et PP lorsque le **système de détection des fuites** est uniquement utilisé pour réduire la **charge libérable** comme cela est déterminé à l'Annexe QQ. L'emplacement des **capteurs de fluide frigorigène** distants n'est pas soumis à l'essai. Les **capteurs de fluide frigorigène** situés à 100 mm ou moins immédiatement sous l'unité ne sont pas considérés comme des **capteurs de fluide frigorigène** distants.*

NOTE 3 Le paragraphe QQ.5.1 précise quand l'Annexe MM ou l'Annexe PP est applicable pour les Articles QQ.3 et QQ.4.

22.121.2 Pour les conditions d'installation des appareils qui utilisent un fluide frigorigène A2 ou A3 et lorsqu'un **système de détection des fuites** est appliqué pour satisfaire aux exigences de l'Annexe GG, ou dans le but de limiter la **charge libérable**, le **capteur de fluide frigorigène** doit être dans l'unité ou en faire partie.

Pour les appareils équipés d'une enveloppe ventilée conforme à l'Article GG.4, le **capteur de fluide frigorigène** doit se trouver dans l'enveloppe ventilée.

NOTE Il est possible d'utiliser plus d'un **capteur de fluide frigorigène** pour satisfaire aux exigences de l'Annexe GG.

*La vérification de l'emplacement du **capteur de fluide frigorigène** du **système de détection des fuites** est effectuée par examen et par des essais conformément à l'Annexe PP. Il n'est pas exigé de procéder à des essais conformément à l'Annexe PP lorsque le **système de détection des fuites** est uniquement utilisé pour réduire la **charge libérable** et que l'appareil a été soumis à l'essai pour vérifier sa conformité à l'Annexe QQ.*

Pour les installations comportant des joints installés sur place qui sont exposés dans l'espace occupé, ces joints doivent satisfaire à au moins l'une des conditions suivantes:

- joints mécaniques conformes à l'ISO 14903;
- joints soudés ou brasés;
- joints figurant dans les enveloppes qui ventilent vers l'unité ou à l'extérieur.

La vérification est effectuée par examen et par essai.

22.122 Pour les **systèmes de détection des fluides frigorigènes** qui sont exigés par la présente norme pour les **fluides frigorigènes inflammables**, ce qui suit s'applique:

- le signal de sortie du **système de détection des fluides frigorigènes** doit activer les actions exigées pour se conformer à l'Annexe GG en cas de fuite;
- lorsque le **capteur de fluide frigorigène** d'un **système de détection des fluides frigorigènes** est utilisé pour activer des mesures de sécurité dans un local qui comporte plusieurs unités, tous les dispositifs de sécurité activés par le système de détection doivent s'appliquer à ces unités du local qui dépendent de ce système de détection des fluides frigorigènes;
- Si un **système de détection des fluides frigorigènes** signale à l'utilisateur que le remplacement du **capteur de fluide frigorigène** est exigé, le réarmement de cette notification ne doit être possible que lorsque le **capteur de fluide frigorigène** a été remplacé.

Le **système de détection des fluides frigorigènes** doit être conforme à l'Annexe LL.

La vérification est effectuée par examen et par les essais de l'Annexe LL.

22.123 Pour les appareils qui utilisent un **fluide frigorigène inflammable** conformément à l'Article GG.9, qui comprennent une section séparée avec des composants contenant du fluide frigorigène, à l'exception des tuyaux (par exemple, compresseurs, **condenseurs**), et qui sont situés dans un local plus petit que $A_{\min}$ conformément à l'Article GG.2, cette section:

- ne doit pas être isolée du flux d'air intérieur, dans lequel une fuite est détectée, ou
- doit être ventilée vers l'extérieur conformément à l'Article GG.4, ou
- doit être ventilée naturellement vers l'extérieur.

La vérification est effectuée par examen.

22.124 Vide

22.125 Les **systèmes frigorifiques** qui remplissent l'ensemble des conditions suivantes peuvent être considérés comme des **systèmes frigorifiques à étanchéité renforcée**:

- a) les compresseurs, les dispositifs de coupure de pression ou les **réceptacles sous pression** du **système frigorifique** ne doivent pas être situés dans l'espace occupé;
- b) les **ensembles de distribution de fluide frigorigène** doivent satisfaire à l'ensemble des exigences applicables de la présente norme;
- c) les **systèmes frigorifiques** ne doivent utiliser que des joints permanents à l'intérieur, à l'exception des joints installés sur site qui relient directement l'unité intérieure à la tuyauterie de fluide frigorigène, ou des joints mécaniques fabriqués en usine conformément à l'ISO 14903;
- d) les parties qui contiennent du fluide frigorigène dans les unités intérieures doivent être protégées des dommages en cas de défaillance grave des parties mobiles (ventilateurs, courroies, par exemple);
- e) les fluides frigorigènes qui contiennent des tuyaux dans l'espace occupé à l'étude sont installés de sorte qu'ils soient protégés contre les dommages accidentels;
- f) le **système frigorifique** de chaque unité intérieure doit être soumis à des essais d'étanchéité en usine avec un équipement de détection d'une capacité de 3 g par an de fluide frigorigène ou moins, à une pression au moins égale à 0,25 fois la **pression maximale admissible**. Aucune fuite ne doit être détectée.

La vérification du a) au f) est effectuée par examen.

- g) les vibrations supérieures à 0,30 G RMS, lorsqu'elles sont mesurées avec un filtre passe-bas à 200 Hz, ne sont pas permises dans les parties qui contiennent du fluide frigorigène dans l'espace occupé en **fonctionnement normal**.

La vérification est effectuée par un essai:

L'équipement doit être monté conformément aux instructions d'installation. L'unité extérieure doit être reliée directement à l'unité intérieure par la ligne la plus courte définie conformément aux instructions d'installation. Les essais doivent être réalisés en mode ventilateur seulement, en mode chauffage et en mode refroidissement, le cas échéant.

Le niveau de vibration doit être mesuré sur l'ensemble de la plage de vitesses du compresseur et du ventilateur intérieur, comme le permettent les commandes compte tenu des modes de fonctionnement. Des précautions doivent être prises pour que les capteurs de mesure n'influencent pas le niveau de vibration de la ligne et pour que le taux de changement de vitesse soit suffisamment faible pour enregistrer le niveau maximal de vibrations.

- h) les **échangeurs de chaleur intérieurs** doivent être protégés des dommages causés par le gel.

La vérification est effectuée de la manière suivante:

- bobines protégées par des commandes. La vérification est effectuée par examen et, en cas de doute, l'essai pour les bobines antigels doit être réalisé;

- *bobines antigel. La vérification est effectuée en effectuant l'essai des caractéristiques de performance de refroidissement minimales décrit dans l'ISO 5151, l'ISO 13253, l'ISO 15042 ou l'ISO 13256;*
- *bobines sensibles au gel. La vérification est effectuée sur 3 échantillons par l'essai suivant. Les essais cycliques de l'échangeur de chaleur en conditions de givrage confirment que l'échangeur de chaleur a une résistance suffisante pour résister au gel sans défaillance. L'appareil doit fonctionner selon le cycle prévu par les commandes pendant 10 jours. À la fin de l'essai, l'échangeur de chaleur doit satisfaire aux exigences de résistance de l'Annexe EE.*

- i) la vitesse maximale du ventilateur intérieur, en **fonctionnement normal**, doit être inférieure à 90 % de la vitesse maximale admissible du ventilateur spécifiée par le fabricant de la roue de ventilateur. Si le fabricant ne spécifie pas la vitesse maximale admissible du ventilateur, la roue du ventilateur doit être soumise à l'essai comme suit:

La vitesse maximale admissible du ventilateur doit être établie en fonctionnant en continu à 120 % de la vitesse maximale pendant 10 jours. Le ventilateur ne doit pas présenter de défaillance structurelle.

Si les roues de ventilateur non métalliques ont un indice thermique assigné minimal de 65 °C selon l'ISO 2578, un préconditionnement n'est pas exigé.

Si aucun indice thermique assigné n'est disponible pour le matériau, les échantillons doivent être vieillis à 90 °C pendant 168 h. Les échantillons ne doivent pas présenter une réduction de plus de 50 % des valeurs des propriétés non conditionnées 1) à 4) ci-dessous:

- 1) résistance à la traction conformément à l'ISO 527-3;
- 2) résistance à la flexion conformément à l'ISO 178;
- 3) choc d'Izod conformément à l'ISO 180;
- 4) choc-traction conformément à l'ISO 8256.

La vérification est effectuée par examen et par essai.

22.126 Pour les besoins de la présente norme, les **systèmes de lampes germicides UV-C** sont limités aux lampes à mercure basse pression dont l'enveloppe de quartz présente un éclairement spectral continu à 254 nm.

NOTE L'enveloppe de quartz bloque la longueur d'onde résonnante de 185 nm pour le mercure qui peut générer de l'ozone.

La vérification est effectuée par examen.

22.127 L'enveloppe de l'appareil, les **lampes UV-C** et les **barrières UV-C** doivent être situées de manière que l'**éclairement spectral UV-C** ne soit pas émis à l'extérieur de l'appareil dans un espace occupé à un niveau dépassant la limite d'éclairement spécifiée en 32.101.1.

La vérification est effectuée par examen et par un essai selon le 32.101.

L'entrée et la sortie du débit d'air intérieur de l'appareil doivent être considérées comme des voies de rayonnement possibles. Les filtres de l'unité ne sont pas considérés comme des barrières UV-C.

22.128 Pour les appareils qui utilisent des **systèmes de lampes germicides UV-C** et qui comportent des portes et/ou des panneaux permettant un accès direct à une zone de l'appareil où l'**éclairement spectral UV-C** mesuré est supérieur à 1,7 µW/cm², les portes et/ou les panneaux doivent être équipés d'un interrupteur de verrouillage permettant de couper l'alimentation des lampes lorsqu'il est ouvert.

La vérification est effectuée par examen, par un essai à la main et par l'essai du 32.101.

*Si un interrupteur est utilisé pour mettre hors tension les **lampes UV-C** de manière à satisfaire aux exigences établies, il ne doit pas être possible d'utiliser l'interrupteur au calibre d'essai B de l'IEC 61032.*

22.129 Pour les zones d'accès destinées à l'**entretien par l'utilisateur**, l'**éclairage spectral UV-C** ne doit pas dépasser la limite spécifiée en 32.101.2, les panneaux d'accès étant ouverts ou retirés selon les besoins pour effectuer l'**entretien par l'utilisateur** exigé. Les panneaux qui sont ouverts ou retirés pour effectuer l'**entretien par l'utilisateur** doivent être fermés ou remis en place pour assurer le bon fonctionnement de l'appareil.

La vérification est effectuée par examen et par un essai selon le 32.101.

22.130 Si l'utilisateur peut remplacer la **lampe UV-C**, l'appareil doit être construit de sorte que:

- le remplacement de la **lampe UV-C** soit facilement possible;
- si des vis ou des composants ne sont pas installés ou qu'ils sont mal positionnés ou fixés, l'appareil devient inutilisable ou n'est manifestement pas complet.

La vérification est effectuée par examen.

22.131 Les appareils qui utilisent des fluides frigorigènes dans un **système frigorifique transcritique** doivent être équipés d'un **dispositif limiteur de pression** qui ne fonctionne pas à une pression supérieure à la **pression maximale admissible** en tenant compte de la tolérance du **dispositif limiteur de pression**.

La vérification est effectuée par examen.

22.132 Vannes d'arrêt de sécurité pour les fluides frigorigènes inflammables afin de limiter la charge libérable

Les **vannes d'arrêt de sécurité** doivent se mettre par défaut en position entièrement fermée lorsque l'appareil est hors tension pour toute autre raison qu'une défaillance du réseau d'alimentation.

NOTE 1 Si l'appareil est alimenté par un **cordon d'alimentation** équipé d'une fiche, le débranchement de cette fiche n'est alors pas considéré comme une défaillance du réseau d'alimentation.

NOTE 2 L'alimentation de secours peut être utilisée pour fermer les vannes motorisées, par exemple des condensateurs ou des batteries.

Les **vannes d'arrêt de sécurité** qui sont activées par un **système de détection des fuites** doivent soit

- être réarmées manuellement, ce qui nécessite l'aide d'un **outil**, soit
- être réarmées automatiquement après que le **système de détection des fuites** n'ait pas détecté de fluide frigorigène pendant au moins 2 heures.

Pour les **systèmes frigorifiques** qui utilisent des fluides frigorigènes A2 ou A3, des **vannes d'arrêt de sécurité** doivent être montées en usine dans l'appareil.

La vérification est effectuée par examen.

Le taux de fuite total au siège pour le fluide frigorigène utilisé pour toutes les **vannes d'arrêt de sécurité** qui réduisent la fuite dans le même espace ne doit pas être supérieur à m_{sv} :

$$m_{sv} = 4 \times LFL \quad (102)$$

où

m_{sv} est le taux de fuite total au siège en gramme par seconde (g/s);

LFL est la **limite inférieure d'inflammabilité** en kilogramme par mètre cube (kg/m³);

4 est une constante.

NOTE 3 m_{sv} est le taux de fuite total libéré dans le local par les **vannes d'arrêt de sécurité** en cas de fuite dans les parties intérieures.

NOTE 4 La formule pour m_{sv} est fondée sur une **charge maximale de fluide frigorigène** de m_1 pour les **systèmes frigorifiques** qui utilisent des **fluides frigorigènes A2L** et de m_2 pour les **systèmes frigorifiques** qui utilisent des fluides frigorigènes A2 ou A3.

La vérification est effectuée par l'essai suivant.

*La **vanne d'arrêt de sécurité** doit être soumise à un essai cyclique, au cours duquel elle est ouverte et fermée un certain nombre de fois en fonction de sa fonction prévue:*

- *une **vanne d'arrêt de sécurité** qui s'active en parallèle avec le cycle du compresseur: 100 000 cycles;*
- *une **vanne d'arrêt de sécurité** qui ne s'active qu'en réponse à un **système de détection des fuites** et lorsque l'appareil est hors tension: 1 000 cycles.*

Avant et après ce cycle d'essai, la fuite au siège doit satisfaire à l'essai ci-dessous, où le taux de fuite à chacune des pressions d'essai ne doit pas dépasser m_{sv} .

La fuite au siège doit être mesurée à l'accès de sortie de la vanne, à toutes les pressions suivantes appliquées à l'entrée de la vanne pendant 1 minute:

- *0,02 × **pression maximale admissible**;*
- *0,5 × **pression maximale admissible**; et*
- *1,0 × **pression maximale admissible**.*

L'essai doit être effectué avec de la vapeur de fluide frigorigène ou d'autres gaz ayant une propriété connue.

NOTE 5 Des essais équivalents, par exemple un essai d'étanchéité à l'air ou à l'hélium, sont permis, à condition qu'il soit prouvé que l'essai d'étanchéité atteint au moins les mêmes performances que l'essai avec de la vapeur de fluide frigorigène.

Les **vannes d'arrêt de sécurité** doivent être marquées avec des informations pour permettre l'identification de la vanne en cas de remplacement:

- moyens d'identification des **vannes d'arrêt de sécurité** pour faciliter le remplacement correct, et
- flèche qui indique le sens du flux, le cas échéant.

La vérification est effectuée par examen.

La fermeture des **vannes d'arrêt de sécurité** dans les conduites de fluide frigorigène liquide ne doit pas entraîner de pression dépassant la **pression maximale admissible**.

NOTE 6 L'objectif est d'éviter les pressions excessives dues à un choc hydraulique ou à un fluide frigorigène liquide piégé qui peut se dilater lorsque la température change.

*La vérification est effectuée en mesurant la pression avant et après la vanne avec un capteur de pression à réponse rapide dont la résolution temporelle n'est pas supérieure à 0,1 seconde lors de l'ouverture et de la fermeture de la vanne à la vitesse la plus élevée du fluide frigorigène liquide en **fonctionnement normal**.*

22.133 Le **matériau en mousse de particules** ne doit pas être utilisé à l'extérieur sans l'application d'un revêtement de protection en métal ou en plastique rigide si l'appareil est accessible au grand public.

La vérification est effectuée par examen et par mesurage.

22.134 Les appareils doivent être construits de sorte que le polypropylène expansé constitué de **matériau en mousse de particules** soit séparé des parties métalliques qui contiennent du cobalt, du manganèse ou du cuivre s'ils fonctionnent à une température supérieure à 80 °C.

NOTE Le contact direct de la mousse de polypropylène expansé (marquage du matériau selon l'ISO 1043-1: PP-E) avec du cobalt, du manganèse ou du cuivre provoque la dégradation du matériau en mousse de polypropylène expansé à des températures supérieures à 80 °C.

Toutefois, cette exigence n'est pas applicable pour les parties constituées de **matériau en mousse de particules** lorsqu'une détérioration de 3 mm au point de contact n'entraîne pas la non-conformité de l'appareil à cette norme. Si la séparation est assurée par un espace d'air, celui-ci doit être d'au moins 3 mm.

La vérification est effectuée par examen et par mesurage.

23 Conducteurs internes

L'article de la Partie 1 est applicable avec l'exception suivante.

23.101 Les conducteurs doivent être protégés s'ils peuvent être endommagés par le contact avec la tuyauterie de fluide frigorigène.

NOTE La tuyauterie de fluide frigorigène peut détruire l'isolation du câble par le mouvement relatif entre le tuyau et le conducteur dû aux vibrations, même si les vibrations ne sont pas fortes.

La vérification est effectuée par examen.

24 Composants

L'article de la Partie 1 est applicable avec les exceptions suivantes.

24.1 Addition:

Les motocompresseurs doivent:

- satisfaire à l'IEC 60335-2-34 (y compris son Annexe AA), ou
- satisfaire à l'IEC 60335-2-34 (sans l'Annexe AA) et satisfaire à l'Article 11 de la présente norme, ou

NOTE 101 Le motocompresseur comprend son système de protection et de commande du motocompresseur utilisé pour la conformité à l'IEC 60335-2-34.

- satisfaire à la présente norme et doivent, en outre, satisfaire à l'IEC 60335-2-34:2021, 22.9.

24.1.4 Modification:

–	coupe-circuit thermiques à réarmement automatique	3 000
–	autres coupe-circuit thermiques sans réarmement automatique	300

Addition:

–	thermostats de commande de motocompresseur	100 000
–	relais de démarrage du motocompresseur	100 000
–	protecteurs thermiques de moteur à réarmement automatique pour motocompresseurs de types hermétique et semi-hermétique	min 2 000 (sans être inférieur au nombre de déclenchements au cours de l'essai à rotor bloqué)
–	protecteurs thermiques de moteur à réarmement manuel, pour les motocompresseurs de types hermétique et semi-hermétique	50
–	autres protecteurs thermiques de moteur à réarmement automatique	2 000
–	autres protecteurs thermiques de moteur à réarmement manuel	30
–	systèmes de détection des fluides frigorigènes à réarmement automatique	300
–	systèmes de détection des fluides frigorigènes sans réarmement automatique	30
–	preuve électromécanique de commande du débit d'air	100 000
–	dispositifs de limitation de pression électriques à réarmement automatique	3 000
–	dispositifs de limitation de pression électriques sans réarmement automatique	300

24.101 Les dispositifs de commande thermiques comportant des parties remplaçables doivent être marqués de façon à pouvoir identifier les parties remplaçables.

La partie remplaçable doit être marquée de la même façon.

La vérification est effectuée par un examen des marques et indications.

24.102 Les **dispositifs de limitation de pression** utilisés dans les **systèmes frigorigères transcritiques** doivent être conformes à l'IEC 60730-2-6 et

- doivent être de type 2A ou 2B;
- doivent comporter un mécanisme à déclenchement libre de type 2J;
- la tolérance sur la poussée ne doit pas dépasser + 0 %.

La vérification est effectuée par examen.

25 Raccordement au réseau et câbles souples extérieurs

L'article de la Partie 1 est applicable avec les exceptions suivantes.

25.1 Addition:

Les appareils peuvent être livrés avec un **câble d'alimentation** équipé d'une fiche de prise de courant:

- si le **cordon d'alimentation** équipé d'une fiche est destiné à être utilisé uniquement à l'intérieur des bâtiments;
- s'ils ont une intensité assignée marquée de 25 A ou moins; et
- s'ils satisfont aux exigences applicables aux appareils raccordés par câble souple existant dans les pays, où ils doivent être utilisés.

Modification:

Les appareils ne doivent pas comporter de socle de connecteur.

25.7 Addition:

Les **câbles d'alimentation** des parties d'appareils pour usage extérieur ne doivent pas être plus légers que le câble souple sous gaine ordinaire de polychloroprène (dénomination 60245 IEC 57).

26 Bornes pour conducteurs externes

L'article de la Partie 1 est applicable.

27 Dispositions en vue de la mise à la terre

L'article de la Partie 1 est applicable avec l'exception suivante:

27.5 Addition:

NOTE 101 Si la continuité de masse entre les composants du système satisfait aux les valeurs maximales spécifiées en 27.5, elle est réputée satisfaire les exigences sans conducteurs de terre spécifiques.

28 Vis et connexions

L'article de la Partie 1 est applicable.

29 Distances dans l'air, lignes de fuite et isolation solide

L'article de la Partie 1 est applicable avec les exceptions suivantes.

Addition:

La vérification n'est pas effectuée sur les parties reliées aux motocompresseurs si les motocompresseurs sont conformes à l'IEC 60335-2-34. Pour les motocompresseurs non conformes à l'IEC 60335-2-34, les additions et modifications spécifiées dans l'IEC 60335-2-34:2021, Article 29 sont applicables.

29.2 Addition:

Pour l'isolation située dans un débit d'air, le microenvironnement présente un degré de pollution 3 sous réserve que l'isolation ne soit pas incorporée ou située de sorte qu'elle puisse être exposée à la pollution lors de l'usage normal de l'appareil.

30 Résistance à la chaleur et au feu

L'article de la Partie 1 est applicable avec l'exception suivante.

30.1 Modification:

Ajouter le texte suivant au premier alinéa de la spécification d'essai:

*Cependant, pour les parties extérieures du **matériau en mousse de particules** en*

- Polypropylène expansé (EPP), ou*
- Polystyrène expansé (EPS).*

*qui ne supportent pas les **parties actives** et qui ont une épaisseur d'au moins 8 mm et une densité égale ou supérieure à 55 kg/m³ et inférieure ou égale à 250 kg/m³, la vérification est effectuée par l'essai du 30.101.*

NOTE 101 Le mesurage de la densité peut être effectué conformément à l'ISO 845.

30.2.2 Non applicable.

30.101 L'essai à la bille pour le **matériau en mousse de particules** est effectué à l'aide de l'appareil spécifié dans l'IEC 60695-10-2:2014, Article 5 en utilisant le dispositif de chargement représenté à la Figure 1a avec des dimensions et une forme supplémentaires comme cela est représenté à la Figure 105.

La taille de l'échantillon d'essai doit être d'au moins 60 mm x 60 mm.

Le poids doit être appliqué sur la surface extérieure de la partie, et non sur une découpe exposant un substrat intérieur aux fins de la préparation de l'échantillon.

L'échantillon d'essai doit être stocké pendant au moins 24 heures avant l'essai dans une atmosphère dont la température est comprise entre 15 °C et 35 °C et l'humidité relative entre 45 % et 75 %.

Placer l'échantillon d'essai au centre approximatif du support de l'échantillon d'essai en vérifiant que sa surface supérieure est horizontale. Abaisser doucement la bille du dispositif de chargement sur le centre approximatif de l'échantillon d'essai. Vérifier qu'il n'existe pas de conditions susceptibles de faire bouger la bille autrement que dans une direction descendante pendant l'essai.

L'installation de l'échantillon d'essai et l'application du poids doivent être effectuées dans un délai de 30 secondes. La chambre d'essai doit revenir à la température spécifiée (± 2 °C) en 5 min et sans dépassement de 5 °C.

L'échantillon d'essai avec le dispositif de chargement doit rester pendant une durée de 60^{+2}_0 min dans la chambre d'essai.

L'épaisseur de l'échantillon au point de contact avec le dispositif de chargement doit être mesurée avant et immédiatement après le conditionnement dans la chambre conformément à la Figure 106.

L'essai doit être effectué à une température supérieure de (40 ± 2) K à l'échauffement maximal mesuré sur la surface accessible pendant l'essai de l'Article 11, mais non inférieure à 75 °C.

NOTE 2 Il peut y avoir une grande différence entre la surface interne et la surface externe de l'isolation thermique.

Toutefois, pour les parties qui fournissent une **isolation supplémentaire** ou une **isolation renforcée**, l'essai doit être effectué à une température supérieure de (25 ± 2) K à l'échauffement maximal mesuré pendant l'essai de l'Article 19, si celui-ci est supérieur. Les échauffements de l'Article 19 ne sont pas pris en considération, à condition que les essais de l'Article 19 soient terminés par un **dispositif de protection sans réarmement automatique**. Le réarmement du **dispositif de protection sans réarmement automatique** doit nécessiter le retrait d'un couvercle ou l'utilisation d'un **outil**.

Après l'essai, l'épaisseur du matériau ne doit pas être inférieure à 50 % de l'épaisseur du matériau d'origine, mais pas inférieure à 4 mm.

31 Protection contre la rouille

L'article de la Partie 1 est applicable avec l'exception suivante.

Addition:

La vérification est effectuée par l'essai au brouillard salin de l'IEC 60068-2-52, la sévérité 2 étant applicable.

Avant l'essai, les revêtements sont éraflés au moyen d'une broche en acier trempé, dont l'extrémité a la forme d'un cône avec un angle de 40° . Sa pointe est arrondie avec un rayon de $0,25 \text{ mm} \pm 0,02 \text{ mm}$. La broche est chargée de sorte que la force exercée le long de son axe soit de $10 \text{ N} \pm 0,5 \text{ NN}$. Les éraflures sont pratiquées en tirant la broche le long de la surface du revêtement à une vitesse d'environ 20 mm/s . Cinq éraflures sont pratiquées à intervalles d'au moins 5 mm et à au moins 5 mm des bords.

Après l'essai, l'appareil ne doit pas être détérioré à un point tel que la conformité à la présente norme soit compromise. Le revêtement ne doit pas être rompu et ne doit pas s'être détaché de la surface métallique.

NOTE 101 Cet essai peut notamment affecter la conformité à l'Article 8 et à l'Article 27.

32 Rayonnement, toxicité et dangers analogues

L'article de la Partie 1 est applicable avec l'exception suivante.

32.101 Essai d'éclairement UV-C

32.101.1 Pour l'espace occupé à l'extérieur de l'unité, un essai doit être effectué afin de déterminer l'**éclairement spectral UV-C**. Les émissions de l'équipement ne doivent pas dépasser une limite d'**éclairement spectral UV-C** de $0,2 \mu\text{W}/\text{cm}^2$.

NOTE La limite d'**éclairement spectral UV-C** de $0,2 \mu\text{W}/\text{cm}^2$ équivaut à $0,1 \mu\text{W}/\text{cm}^2$ d'éclairement effectif à 254 nm (par exemple, $0,2 \mu\text{W}/\text{cm}^2$ multiplié par la fonction de danger, $S_{UV} = 0,5$ à 254 nm comme cela est défini dans l'IEC 62471 équivaut à $0,1 \mu\text{W}/\text{cm}^2$). L'éclairement effectif de $0,1 \mu\text{W}/\text{cm}^2$ est classé comme sans risque dans l'IEC 62471.

32.101.2 Pour les zones à l'intérieur de l'appareil qui sont accessibles dans le cadre de l'**entretien par l'utilisateur** et qui ne sont pas équipées du verrouillage exigé au 22.128, l'**éclairement spectral UV-C** ne doit pas être supérieur à $1,7 \mu\text{W}/\text{cm}^2$. L'**éclairement spectral UV-C** est mesuré à n'importe quel point d'accessibilité exigé pour l'**entretien par l'utilisateur**. Pour déterminer l'accessibilité de l'utilisateur, il convient de tenir compte de la durée d'exposition maximale de 60 min/jour à un **éclairement spectral** de $1,7 \mu\text{W}/\text{cm}^2$, que l'utilisateur peut rencontrer dans l'exercice de ses fonctions.

NOTE La limite d'éclairement spectral UV-C de $1,7 \mu\text{W}/\text{cm}^2$ équivaut à $0,85 \mu\text{W}/\text{cm}^2$ d'éclairement effectif à 254 nm (par exemple, $1,7 \mu\text{W}/\text{cm}^2$ multiplié par la fonction de danger, $S_{UV} = 0,5$ à 254 nm comme cela est défini dans l'IEC 62471 équivaut à $0,85 \mu\text{W}/\text{cm}^2$).

La conformité est déterminée en mesurant l'éclairement spectral UV-C selon l'IEC 62471:2006, Article 5 et Annexe B.

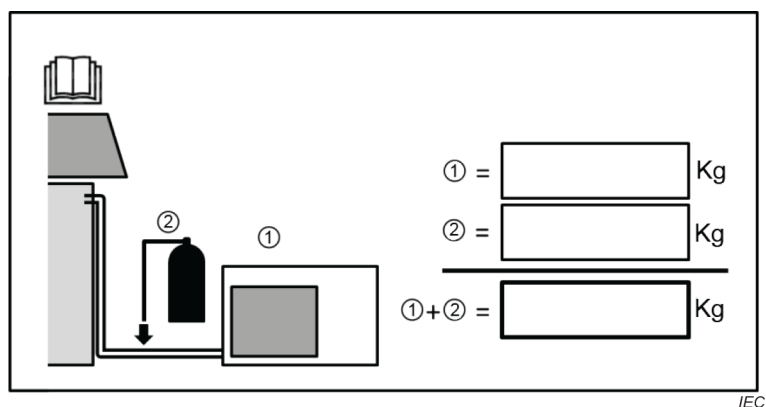
32.101.3 L'éclairement spectral UV-C doit être mesuré à l'emplacement indiqué dans le Tableau 102.

Tableau 102 – Emplacement de mesure de l'éclairement spectral UV-C

	Limites de l'éclairement spectral UV-C		Pour conformité, l'éclairement spectral UV-C est mesuré
	$\mu\text{W}/\text{cm}^2$	W/m^2	
Espace occupé à l'extérieur de l'unité	$\leq 0,2^a$	$\leq 0,002$	À 0,3 m de toutes les surfaces extérieures de l'appareil ^c
Ouvertures d'air de refoulement et d'admission	$\leq 0,2^a$	$\leq 0,002$	À 0,3 m du plan perpendiculaire de l'ouverture
Ouvertures pour l'entretien par l'utilisateur ^b	$\leq 1,7$	$\leq 0,017$	À 0,3 m du plan perpendiculaire de l'ouverture d'accès
Remplacement de la lampe UV-C			Non exigé – l'alimentation doit être déconnectée
^a L'éclairement effectif inférieur ou égal à $0,1 \mu\text{W}/\text{cm}^2$ est classé sans risque dans l'IEC 62471. L'éclairement spectral est de $0,2 \mu\text{W}/\text{cm}^2$ à 254 nm. ^b En admettant par hypothèse une durée d'exposition maximale de 60 min/jour. ^c Si l'appareil possède une fenêtre d'inspection, la distance de mesure est réduite à 0,0 m.			

32.101.4 Lors des essais d'éclairement spectral UV-C:

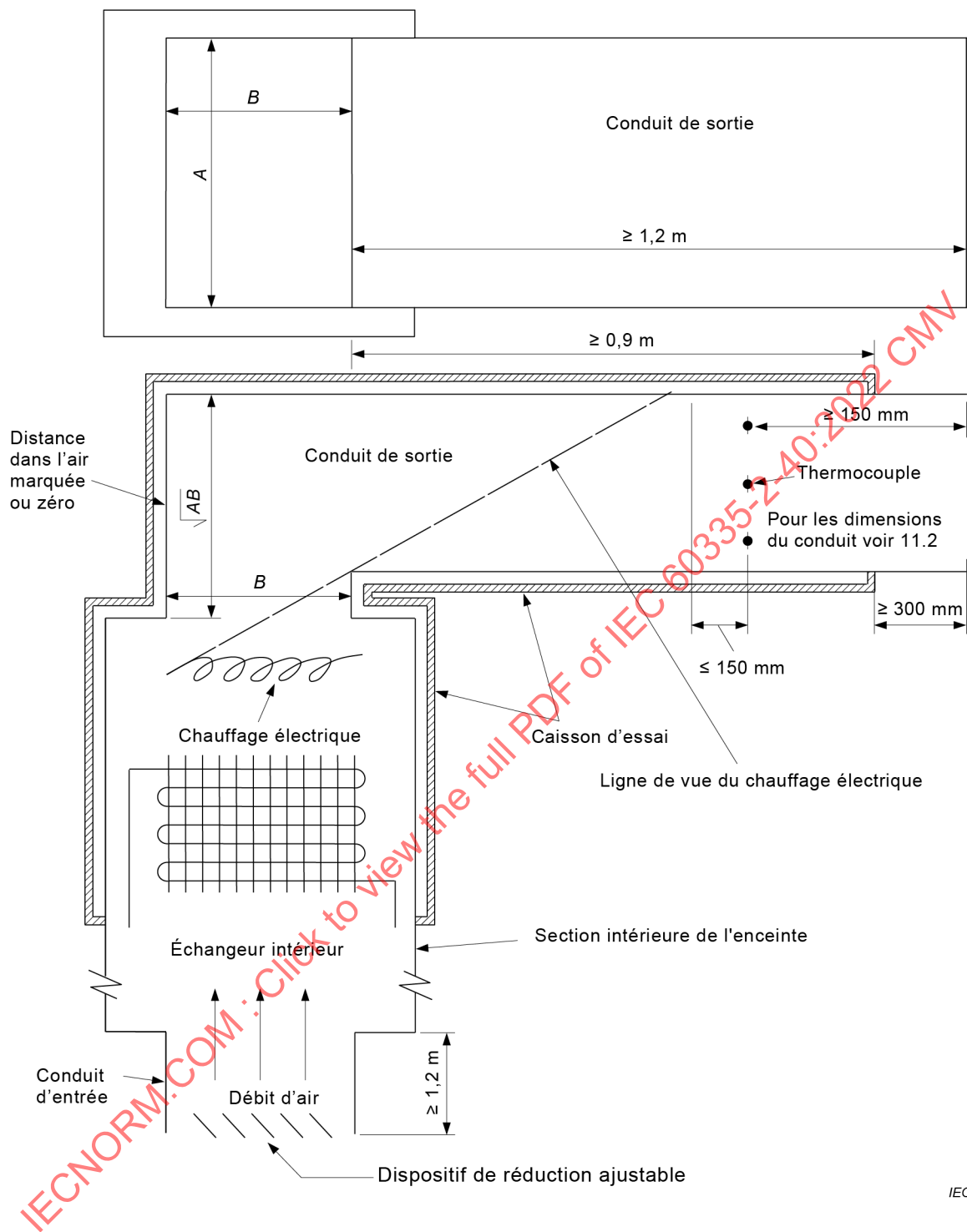
- les mesurages d'éclairement spectral UV-C doivent être réalisés à l'aide d'un spectroradiomètre à balayage ou d'un radiomètre à bande étroite;
- tous les panneaux et composants doivent être positionnés ou ajustés dans la position la plus sévère;
- les filtres à air amovibles doivent être enlevés;
- les mesurages doivent être effectués à l'endroit et à l'angle d'incidence les plus défavorables;
- les caractéristiques de conduit et de configuration minimales spécifiées par le fabricant, y compris tout revêtement du conduit, doivent être en place et les mesurages doivent être réalisés au niveau de l'ouverture à l'extrémité du conduit.

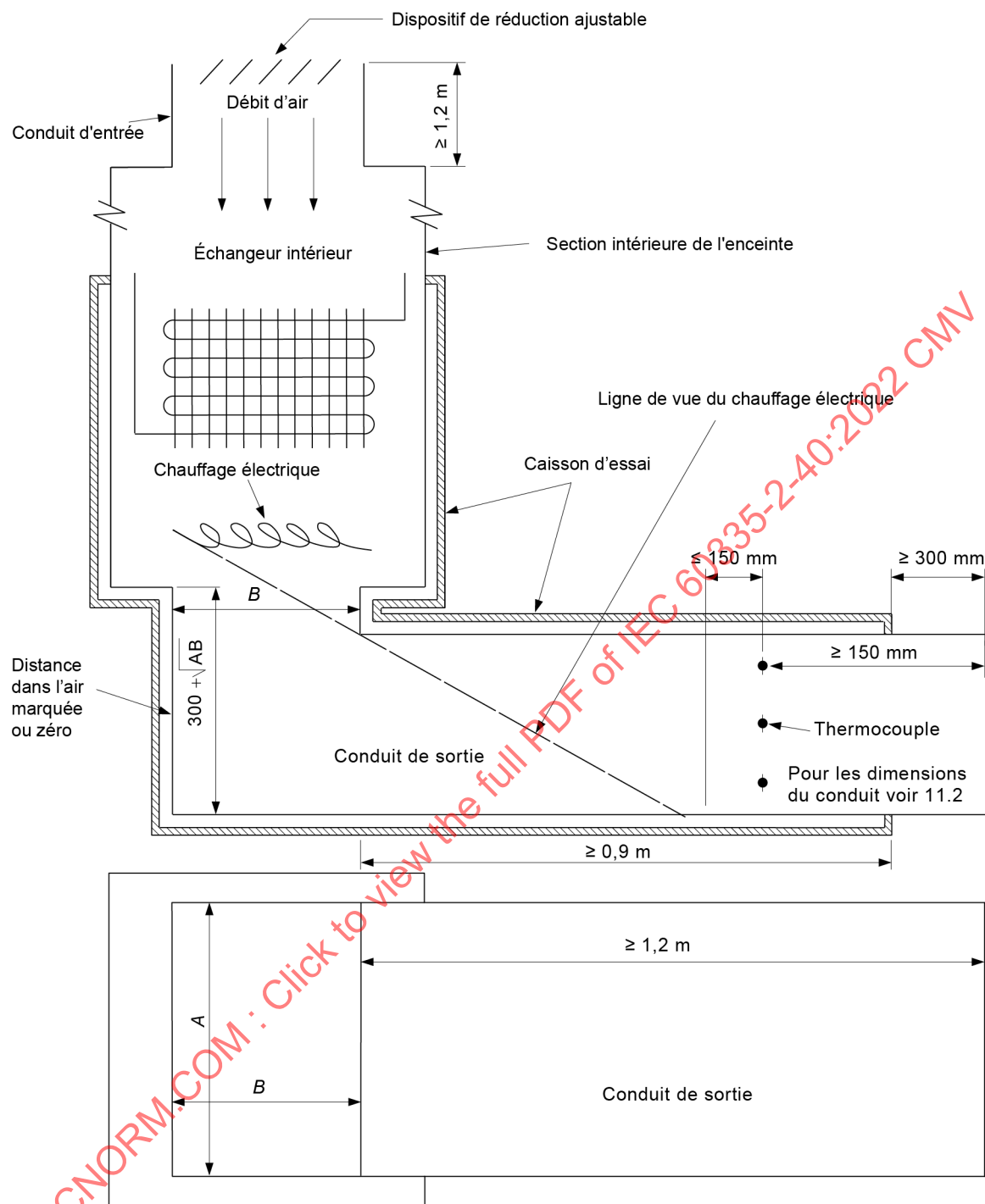
**Légende**

Exemple 1 **charge de fluide frigorigène** de la partie préchargée de l'appareil

Exemple 2 **charge de fluide frigorigène** ajoutée au cours de l'installation

Figure 101 – Exemple d'étiquette pour les unités chargées sur place

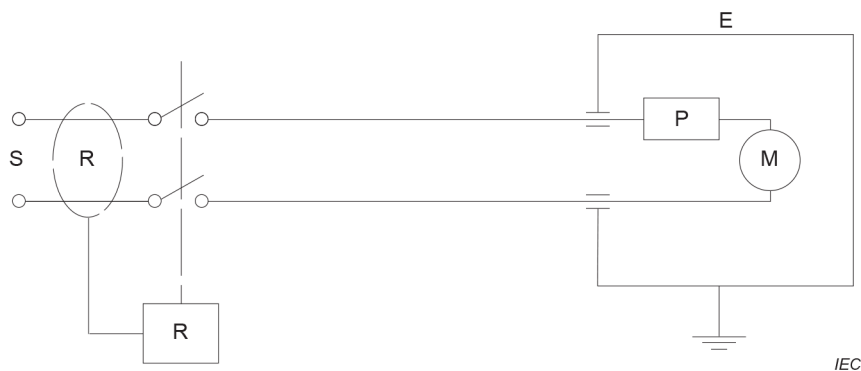




IEC

b) Application en aval

Figure 102 – Montage d'essai d'échauffement pour les appareils comportant un chauffe-air supplémentaire



Légende

S alimentation

E enveloppe du moteur

R dispositif à courant différentiel résiduel ($I_{\Delta n} = 30 \text{ mA}$)
(RCCB ou RCBO)

P **dispositif de protection** (externe ou interne)

M moteur

Figure 103 – Circuit d'alimentation pour l'essai en rotor bloqué d'un moteur monophasé – à réviser au besoin pour l'essai triphasé



Figure 104 – Profil de densité spectrale de puissance pour l'essai de vibration du 21.101

Dimensions en millimètres

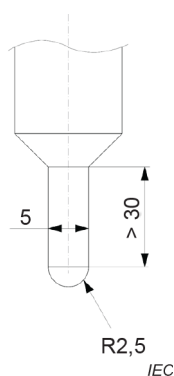


Figure 105 – Détails dimensionnels du poids dans la zone de la bille de pression