IEC 60335-2-40

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INTERNATIONAL STANDARD

colour inside

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

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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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International Standard 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.

This fifth edition cancels and replaces the fourth edition published in 2002, its Amendment 1 (2005), its Amendment 2 (2005) and its Corrigendum 1 (2006). It constitutes a technical revision.

The principal changes in this edition as compared with the fourth edition are as follows (minor changes are not listed):

– 3.127 and 3.128 – added new definitions;
– 5.10 – length of refrigerant lines now specified for testing;
– 7.1 – changed marking requirements for **flammable refrigerants**;

– 8.15 – added requirement to clarify the placement of installation panels during testing;
– 11.2.1 – clarification of test procedure;
– 19 – (whole clause) – replaced in its entirety;
– 21.2 – added new coverage for vibration considerations during transport;
– 22.46 – added clarification for PEC;
– 22.118 – added coverage for use of mechanical connectors indoors when employing **flammable refrigerants**;
– 32 – made this section of Part 1 applicable;
– Annex FF2.4 – revised calculation for calculating volume (V);
– Annex FF2.5 – revision of allowable concentration of flammable refrigerant gas;
– Annex GG8 – new coverage added;
– Annex HH – added informative annex.

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

FDIS	Report on voting
61D/213/FDIS	61D/220/RVD

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

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

This part 2 is to be used in conjunction with the latest edition of IEC 60335-1 and its amendments. It was established on the basis of the fifth edition (2010) of that standard.

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

This part 2 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 publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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

A bilingual version of this publication may be issued at a later date.

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.

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

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

If 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 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**, **air-conditioners**, and **dehumidifiers** incorporating motor-compressors and hydronic room **fan coils**, their maximum **rated voltages** being not more than 250 V for single phase appliances and 600 V for all other appliances.

Appliances not intended for normal household use but which nevertheless may 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.

This standard also applies to electric **heat pumps**, **air conditioners** and **dehumidifiers** containing **flammable refrigerant**. **Flammable refrigerants** are defined in 3.121.

The appliances referenced above may 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 refrigeration safety are covered by ISO 5149, and 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 chemicals other than group A1, A2, or A3 as defined by ANSI/ASHRAE 34 [ISO 817] classification.

This standard specifies particular requirements for the use of **flammable refrigerants**. Unless specifications are covered by this standard, including the annexes, requirements for refrigerating safety are covered by ISO 5149.

The sections and clauses in ISO 5149 of particular concern to this standard are as follows:

– Section 3: "Design and construction of equipment" applies to all appliances and systems.
– Section 4: "Requirements for utilization" applies to appliances and systems which are for “similar electrical appliances”, i.e. commercial and light industrial.
– Section 5: "Operating procedures" applies to appliances and systems which are for “similar electrical appliances”, i.e. commercial and light industrial.

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 103 Attention is drawn to the fact that

– for appliances intended to be used in vehicles or on board ships or aircraft, additional requirements may 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 104 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 60079-14, *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*

ISO 817:2005, *Refrigerants – Designation system*

ISO 5149:1993, *Mechanical refrigerating systems used for cooling and heating – Safety requirements*

ISO 7010: 2011, *Graphic Symbols – Safety colours and safety signs – Registered safety signs*

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

ANSI/ASHRAE 34:2010, *Designation and safety classification of refrigerants*

ASTM D4728-01:2001, *Standard Test Method for Random Vibration Testing of Shipping Containers*

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 as in normal use and is operating under the most severe operating conditions specified by the manufacturer

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.

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 refrigeration system for cooling and possibly dehumidifying the air.

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

3.104

dehumidifier

encased assembly designed to remove moisture from its surrounding atmosphere

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

3.105

dehumidification – comfort

dehumidification to reduce the humidity within a space to a level to satisfy the requirements of the occupants

3.106

dehumidification – process

dehumidification to reduce the humidity within a space to a level necessary for the process or the storage of goods and/or materials or the drying out of the building fabric

3.107

dehumidification – heat recovery

dehumidification where the latent and sensitive heat removed from the space together with the compressor heat is reused in another application rather than rejected outside to waste

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

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 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 refrigeration circuit

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
self-contained unit
complete appliance, in suitable frame(s) or enclosure(s), that is fabricated and shipped in one or more sections, and has no refrigerant containing parts connected in the field other than by companion or block valves

Note 1 to entry: A **self-contained unit** in a single frame or enclosure is called a single package unit.

Note 2 to entry: A **self-contained unit** in more than one frame enclosure is called a split package unit.

3.118
appliances accessible to the general public
appliances intended to be located in residential buildings or in commercial buildings

3.119
appliances not accessible to the general public
appliances which are intended to be maintained by qualified service personnel and located either in machine rooms and the like or at a level not less than 2,5 m or in secured rooftop areas

3.120
fan coil
air handling unit
factory-made assembly which provides one or more of the functions of forced circulation of air, heating, cooling, dehumidification and filtering of air, but which does not include the source of cooling or heating

Note 1 to entry: The device is normally designed for free intake of air from a room and delivery of air into the same room, but may be applied with duct work.

Note 2 to entry: This device may be designed for furred-in application or with an enclosure for application within the conditioned space.

3.121
flammable refrigerant
refrigerant with a classification of class A2 or A3 in compliance with ANSI/ASHRAE 34 [ISO 817] classification

3.122
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

3.123
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

Note 1 to entry: Maximum allowable pressure constitutes a limit to the operating pressure whether the equipment is working or not, see Clause 21.

3.124
low-pressure side
part(s) of a refrigerating system operating at the evaporator pressure

3.125
high-pressure side
part(s) of a refrigerating system operating at the condenser pressure

3.126
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

3.127
factory sealed appliance
appliance in which all refrigerating system parts have been sealed tight by welding, brazing or a similar permanent connection during the manufacturing process

3.128
single package unit
factory assembly of components of refrigeration system fixed on a common mounting to form a discrete unit

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.

The temperatures on the refrigerant piping should be measured during the test of Clause 11.

NOTE 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.

5.6 *Addition:*

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

5.7 *Replacement:*

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. 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.*

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:*

Replace the second dash by:

– symbol for nature of supply including number of phases, unless for single phase operation;

Addition:

– rated frequency;
– mass of the refrigerant;
– refrigerant number in accordance with ANSI/ASHRAE 34 [ISO 817]
– permissible excessive operating pressure for the storage tank (for **sanitary hot water heat** pumps);
– maximum operating pressure for the heat exchanger for hydronic fan coil/air handling units;
– maximum operating pressure for the refrigerant circuit; if the permissible excessive operating pressure for the suction and discharge side differ, a separate indication is required;
– IP number according to degree of protection against ingress of water, other than IPX0.

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.

The flame symbol and the instruction manual symbol of 7.6 shall be visible when a **flammable refrigerant** is employed and the following conditions exist:

– accessing parts expected to be subjected to maintenance or repair;

– observing the appliance under sale or installed conditions;

– observing the appliance packaging, if the appliance is charged with refrigerant.

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), ISO-7000-1641 (2004-01) and ISO 7000-1659 (2004-01)) shall be placed on the appliance in a location visible to the persons required to know the information. The perpendicular height shall be at least 10 mm.

An additional warning symbol (flame symbol: W021 of ISO 7010) shall be placed on the nameplate of the unit near the declaration of the refrigerant type and charge information. The perpendicular height shall be at least 10 mm, and the symbol need not be in colour. When installed, the marking should be visible after removing a **detachable** part.

The following warning shall also be applied to the appliance when a **flammable refrigerant** is employed.

WARNING **Appliance** shall be installed, operated and stored in a room with a floor area larger than ‘X’ m^2 (only applies to **appliances** that are not **fixed appliances**).

For **appliances**, which are not **fixed appliances**, the minimum room size X shall be specified on the appliance. The X in the marking shall be determined in m^2 by the procedure described in Clause GG.2 for unventilated areas and the X in the marking shall be 4 if the refrigerant charge of the appliance is less than m_1 (see GG.1.1).

The maximum allowable pressure for the low-pressure side and the high-pressure side shall be marked on the product.

NOTE 102 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 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 W021 of ISO 7010, shall be included, without specifying the colour.

7.6 *Addition:*

When a **flammable refrigerant** is employed, a warning symbol W021 of ISO 7010, including colour and format, shall be permanently placed on the appliance. The perpendicular height of the triangle containing the "Caution, risk of fire" symbol shall be at least 30 mm.

When a **flammable refrigerant** is employed, a symbol requiring reference to the manual [ISO 7000-0790 (2004-01)], including colour and format, shall be permanently placed on the appliance.


Symbol ISO 7010- W021 (2011) warning; Risk of fire/Flammable materials


Symbol ISO 7000-1641 (2004-01) operator's manual; operating instructions


Symbol ISO 7000-1659 (2004-01) service indicator; read technical manual

`

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:

– 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 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 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**;

– maximum and minimum water or brine operating temperatures;

– maximum and minimum water or brine operating pressures.

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.

7.15 *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 is intended for permanent connection to fixed wiring with aluminium wires, the marking shall so state.

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 which have a dedicated installation panel or cover and which cannot be installed without them, compliance is checked according to 5.10 (after the installation as instructed in the installation manual).

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.

11.1 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 *Appliances are installed in a test room in accordance with the manufacturer's 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 manufacturer's instructions except for **fan coils** where the flow rates and liquid temperatures shall be the maximum specified in the manufacturer's instructions;*
- *the outlet duct connected to the appliance shall be subjected to the maximum static pressure given in the manufacturer's 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 heaters**, an additional test casing as described in 11.9 is used.*

11.2.1 *For heating tests of ducted appliances with **supplementary 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 the same size as the inlet opening.*

*An appliance that includes or has provision for **supplementary heater** is fitted with a metal outlet duct in accordance with Figure 101a) or Figure 101b), 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.

11.2.2 *A ducted appliance which does not include **supplementary 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 outlet duct is provided with a restricting means to obtain the maximum static pressure given in the manufacturer's instructions.

11.3 *Temperatures other than those of windings are determined by means of fine-wire thermocouples 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 considered to be fine-wire thermocouples.

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.

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.

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

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

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

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 *(1 of 3)*

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*

Table 3 *(2 of 3)*

Parts	*Temperature °C*
– *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*
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.

Table 3 *(3 of 3)*

	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 must 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)*
l	*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.

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 appliances**, the leakage current shall not exceed 2 mA per kilowatt **rated power input** with a maximum value of 10 mA for **appliances accessible to the general public**, and a maximum value of 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 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 manufacturer's 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 manufacturer's 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 this 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 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 manufacturer's 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 0,25 g of ordinary table salt 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 appliances****, the leakage current shall not exceed 2 mA per kilowatt* ***rated power input*** *with a maximum value of 10 mA for* ***appliances accessible to the general public****, and a maximum value of 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 and 19.103, 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 air flow 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.

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**.*

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 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 and Notes 1 and 2 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 102.*

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 °C ± 5 °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.*

Add after the last paragraph:

If the motor-compressor has not been type-tested against the requirements of IEC 60335-2-34, 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 60335-2-34:2012, if applicable, and shall comply with the requirements in 19.104 of IEC 60335-2-34:2012.

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.*

19.11.4 *Modification:*

Add before the first paragraph:

The first paragraph of Part 1 in 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.*

Add after the second paragraph the following:

*If the appliance incorporates more than one **protective electronic circuit**, each **protective electronic circuit** has to 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 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.*

NOTE 101 Components may 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 may possibly be influenced by the wiring and the metal housing of the final application. Therefore, it is recommended that 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 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:*

Footnote a) of Table 9 is not applicable.

19.14 *Addition 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, for example, achieved 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 °C ± 5 °C. When steady conditions are attained, the heat transfer medium flow of the **outdoor heat exchanger** is restricted or shut off, whichever is the most unfavourable without the appliance being non-operative.*

*After this test, **protective devices** that 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 with 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.*

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.*

*The appliances are operated at **rated voltage** or at the upper limit of the **rated voltage range**.*

19.104 All appliances provided with **supplementary heaters** and with free air discharge are subjected to the following test in each mode of operation.

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 kg/m^2 ± 0,4 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 an overshoot of 25 °C is permitted during the first hour.

Thermal protective devices are allowed to operate.

20 Stability and mechanical hazards

This clause of Part 1 is applicable.

21 Mechanical strength

This clause of Part 1 is applicable except as follows.

21.1 *Addition:*

Safety requirements specified in ISO 14903 shall apply.

Safety requirements specified in Annex EE shall apply. The pressure test in Annex EE applies to parts other than pressure vessels.

21.2 *Addition:*

Appliances using **flammable refrigerants** shall withstand the effects of vibration during transport.

The appliance is tested in its final packaging for transport and shall withstand a random vibration test according to ASTM D4728-01.

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.*

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 applied to the conductor after it has been cut.

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

22.46 *Addition 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.

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 manufacturer's installation instructions.

22.102 Appliances provided with supplementary heaters

22.102.1 Appliances provided with **supplementary heaters** for air shall be provided with at least two **thermal cut-outs**. The **thermal cut-out** intended to operate first shall be a **self-resetting thermal cut-out**, the other **thermal cut-out** shall be either a **self-resetting thermal cut-out** or 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 heaters** for water 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 Clause 19.

NOTE Anti-frost heaters are not considered to be supplementary heaters for water, 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 **Non-self-resetting cut-outs** shall be functionally independent of other control devices.

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 hereafter 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 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 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.

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 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 Section 3 of ISO 5149.

22.113 When a **flammable refrigerant** is used, refrigerant tubing shall be protected or enclosed to avoid mechanical damage. The tubing shall be protected to the extent that it will not be handled or used for carrying during moving of the product. Tubing located within the confines of the cabinet 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 for pipe connections or any other refrigerant pressure containing purposes.

22.115 The total refrigerant mass (*M*) of all **refrigerating systems** within the appliance employing **flammable refrigerants** shall not exceed m_3 as defined in Annex GG.

22.116 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 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.

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.

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 be located in an enclosure which satisfies the following:

– shall comply with Clause 20 of IEC 60079-15:2010 for restricted breathing enclosures suitable for use with group IIA gases or the refrigerant used.

– 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 ignition source.

Components and apparatus complying with Clause 8 to 19 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 The test current for a switching component is the rated current of the component or the actual load to be switched, whichever is greater.

22.117 Temperatures on surfaces that may be exposed to leakage of **flammable refrigerants** shall not exceed the auto-ignition temperature of the refrigerant reduced by 100 K; some typical values are given in Annex BB.

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.

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 be displaced during normal operations shall be protected against mechanical damage.

Compliance is checked according to the manufacturer's installation instructions and a trial installation if necessary.

23 Internal wiring

This clause of Part 1 is applicable

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.

24.1.4 *Modification:*

– ***self-resetting thermal cut-outs*** *3 000*
– ***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*

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.

25 Supply connection and external flexible cords

This clause of Part 1 is applicable except as follows.

25.1 *Addition:*

The appliances may be provided with a supply cord fitted with a plug

– if they are 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:*

If the ground continuity between system components meets the minimum 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 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.

30.2.2 Not applicable.

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, in particular with Clauses 8 and 27, is impaired. The coating shall not be broken and shall not have loosened from the metal surface.

32 Radiation, toxicity and similar hazards

This clause of Part 1 is applicable.

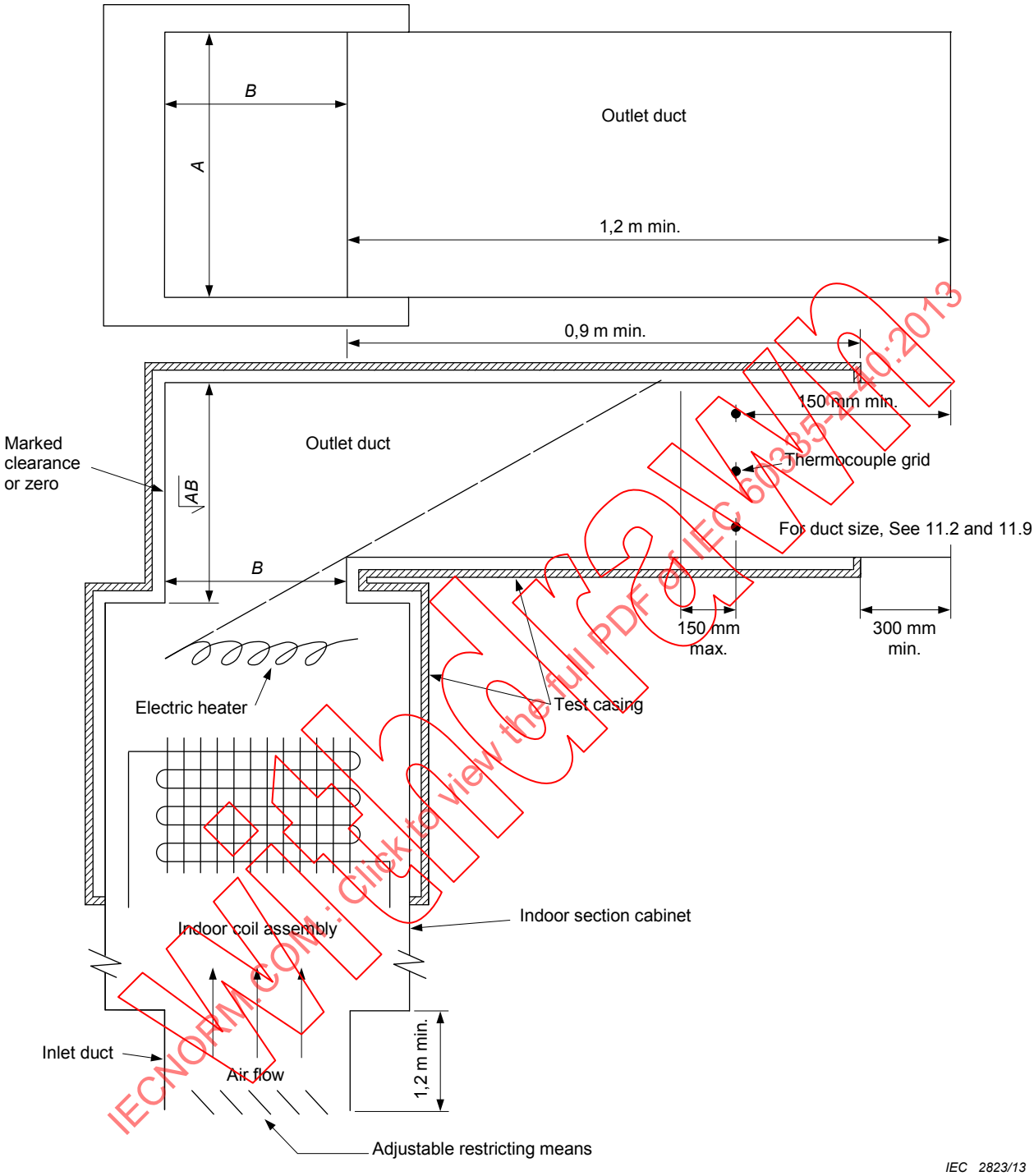


Figure 101a – Upflow application

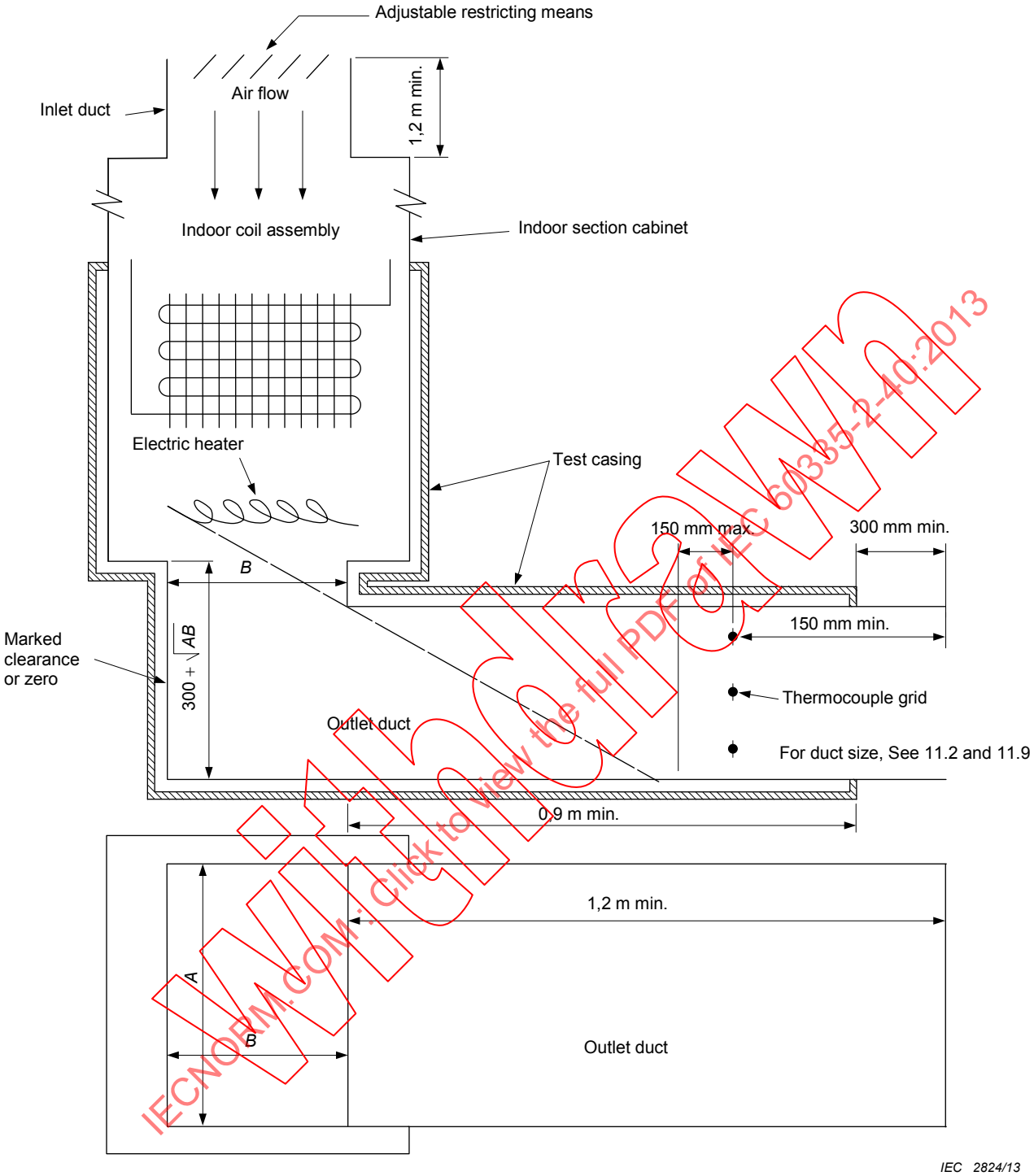
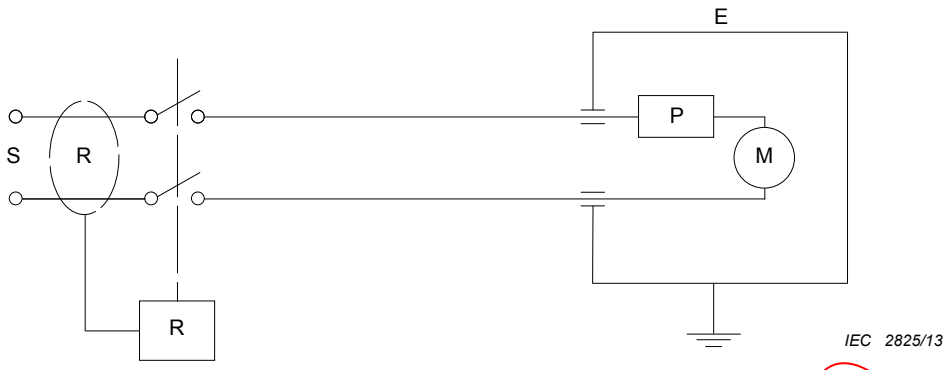


Figure 101b – Downflow application

Figure 101 – Arrangement for heating test of appliances with supplementary heater



Key

S supply

E motor enclosure

R residual current device ($I_{\Delta n}$ = 30 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 102 – Supply circuit for locked-rotor test of a motor of the single-phase type – Revise as needed for three-phase 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.

Annex AA
(informative)

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]	
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		–	–					27	21
	Process								12	9
	Heat recovery (air cooled)						27	21	27	21
	Heat recovery (water cooled)						Water	24	27	21
Sanitary hot water heat pump										
Outside air/Water	A7	W45	7	6	Water	45	–	–	–	–
Ambient air/Water	A15	W45	15	12	Water	45	–	–	–	–
Exhaust air/Water	A20	W45	20	12	Water	45	–	–	–	–
Brine/Water	B0	W45	Brine	0	Water	45	–	–	–	–

[a] DB: dry bulb

[b] WB: wet bulb

NOTE Appliance can be classified according to function and temperature application as noted below:

Source		Sink		Classification		
	Outside air		Recycled air		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.

Annex BB
(normative)

Selected information about refrigerants

The normative component of Annex BB involves the "Lower limit" column of Table BB.1. The rest of the annex is informative.

Table BB.1 – Selected information about refrigerants

Refrigerant designation [a]	Description	Formula	Auto-ignition temperatures °C	Density [b,e] kg/m³	Molar mass[c] kg/kmol	Lower flammability limit[b]	
						kg/m³[d]	% v/v
R32	Difluoromethane	CH_2F_2	648	2,13	52,0	0,306	14,4[g]
R50	Methane	CH_4	645	0,65	16,0	0,032	4,9[h]
R143a	1,1,1 – Trifluoroethane	CF_3CH_3	750	3,43	84,0	0,282	8,2[g]
R152a	1, 1 – Difluoroethane	CHF_2CH_3	455	2,70	66,0	0,130	4,8[g]
R170	Ethane	CH_3CH_3	515	1,23	30,1	0,038	3,1[g]
R290	Propane	$CH_3CH_2CH_3$	470	1,80	44,1	0,038	2,1[g]
R600	n-Butane	$CH_3CH_2CH_2CH_3$	365	2,37	58,1	0,043	1,8[i]
R600a	Isobutane	$CH(CH_3)_3$	460	2,37	58,1	0,043	1,8[j]
R1150	Ethylene	$CH_2=CH_2$	425	1,15	28,1	0,036	3,1[g]
R1270	Propylene	$CH_2=CHCH_3$	455	1,72	42,1	0,040	2,3[k]
E170	Dimethylether	CH_3 °CH_3	235	1,88	46,1	0,064	3,4[l]
R142b	1-chloro-1,1-difluoroethane	CH_3CClF_2	750[f]	4,11	100,5	0,329	8,0[g]

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 × 0,000409 to give the flammability limit in kg/m^3.
e	Divide molar mass by 24,465 to give the density in kg/m^3.
f	Estimated from molecular structure
g	WILSON, DP. and RICHARD, RG. Determination of Refrigerant Lower Flammability Limits in Compliance with Proposed Addendum p to Standard 34. *ASHRAE Transactions:* 2002 V. 108, Pt. 2.
h	BURRELL, GA. and OBERFELL, GG. U.S. Bur. Mines, Tech. Paper 119, (1915)
i	LAFFITTE, P. and DELBOURGO, R. *4th Symp. on Combust.*, p.114(1953)
j	ZABETAKIS, MG., SCOTT, GS., JONES, GW. *Ind. Eng. Chem.*, 43, 2120, (1951)
k	Estimated from LFL for propane analogs and data from JABBOUR, T., CLODIC, D. Burning Velocity and Refrigerant Flammability Classification, Ecole de Mines, Paris, France, *ASHRAE Transactions* 2004.
l	Atofina application to ASHRAE for safety classification of R-E170, 13 December 2001

Annex CC
(informative)

Transportation, marking and storage for units that employ flammable refrigerants

The following information is provided for units that employ **flammable refrigerants**.

CC.1 Transport of equipment containing flammable refrigerants

Attention is drawn to the fact that additional transportation regulations may 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.2 Marking of equipment using signs

Signs for similar appliances used in a work area generally are 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.3 Disposal of equipment using flammable refrigerants

See national regulations.

CC.4 Storage of equipment/appliances

The storage of equipment should be in accordance with the manufacturer's instructions.

CC.5 Storage of packed (unsold) equipment

Storage package protection should be constructed such 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)

Instruction manual for servicing refrigerant containing appliances

DD.1 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 not contain an odour.

The manufacturer may provide other suitable examples or may provide additional information about the refrigerant odour.

DD.2 Information in manual

DD.2.1 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:

– 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;
  - 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 amount (M);
– the minimum rated airflow, if required by Annex GG;
– information for handling, installation, cleaning, servicing and disposal of refrigerant;
– the minimum floor area of the room or the special requirements for the room in which an appliance containing **flammable refrigerants** can be located as defined in Annex GG, except where the refrigerant charge (M) is less than or equal to m_1 ($M \leq m_1$);
– a warning to keep any required ventilation openings clear of obstruction;
– a notice that servicing shall be performed only as recommended by the manufacturer.

DD.2.2 Unventilated areas

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:

– a warning that the appliance shall be stored in a well-ventilated area where the room size corresponds to the room area as specified for operation;

– a warning that the appliance shall be stored in a room without continuously operating open flames (for example an operating gas appliance) and ignition sources (for example an operating electric heater).

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.2.3 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.

Examples for such working procedures are:

– breaking into the refrigerating circuit;

– opening of sealed components;

– opening of ventilated enclosures.

DD.3 Information on servicing

The manual shall contain specific information for service personnel according to DD.3.1 to DD.3.9.

DD.3.1 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.3.3 to DD.3.7 shall be completed prior to conducting work on the system.

DD.3.2 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.3.3 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. The area around the workspace shall be sectioned off. Ensure that the conditions within the area have been made safe by control of flammable material.

DD.3.4 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.3.5 Presence of fire extinguisher

If any hot work is to be conducted on the refrigeration equipment or any associated parts, appropriate fire extinguishing equipment shall be available to hand. Have a dry powder or CO_2 fire extinguisher adjacent to the charging area.

DD.3.6 No ignition sources

No person carrying out work in relation to a refrigeration system which involves exposing any pipe work shall use any sources of ignition in such a manner that it may 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.3.7 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.3.8 Checks to the refrigeration 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 charge size 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;*

– *refrigeration pipe or components are installed in a position where they are unlikely to be exposed to any substance which may 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.3.9 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.4 Repairs to sealed components

DD.4.1 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.4.2 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.

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.5 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.

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.

DD.8 Leak detection methods

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 be adequate, or may 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 suitable for use with most refrigerants but the use of detergents containing chlorine shall be avoided as the chlorine may react with the refrigerant and corrode the copper pipe-work.

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. For appliances containing **flammable refrigerants**, oxygen free nitrogen (OFN) shall then be purged through the system both before and during the brazing process.

DD.9 Removal and 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:

- remove refrigerant;
- purge the circuit with inert gas;
- evacuate;
- purge again with inert gas;
- open the circuit by cutting or brazing.

The refrigerant charge shall be recovered into the correct recovery cylinders. For appliances containing **flammable refrigerants**, the system shall be “flushed” with OFN to render the unit safe. This process may need to be repeated several times. Compressed air or oxygen shall not be used for purging refrigerant systems.

For appliances containing **flammable refrigerants**, flushing shall be achieved by breaking the vacuum in the system with OFN 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 OFN 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.

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

DD.10 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 upright.

– Ensure that the refrigeration system is earthed prior to charging the system with refrigerant.

– Label the system when charging is complete (if not already).

– Extreme care shall be taken not to overfill the refrigeration 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.11 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 reclaimed refrigerant. It is essential that electrical power is available before the task is commenced.

a) Become familiar with the equipment and its operation.

b) Isolate system electrically.

c) Before attempting the procedure, ensure that:

- mechanical handling equipment is available, if required, for handling refrigerant cylinders;
- all personal protective equipment is available and being used correctly;
- the recovery process is supervised at all times by a competent person;
- recovery equipment and cylinders conform to the appropriate standards.

d) Pump down refrigerant system, if possible.

e) If a vacuum is not possible, make a manifold so that refrigerant can be removed from various parts of the system.

f) Make sure that cylinder is situated on the scales before recovery takes place.

g) Start the recovery machine and operate in accordance with manufacturer's instructions.

h) Do not overfill cylinders. (No more than 80 % volume liquid charge).

i) Do not exceed the maximum working pressure of the cylinder, even temporarily.

j) 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.

k) Recovered refrigerant shall not be charged into another refrigeration system unless it has been cleaned and checked.

DD.12 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 Recovery

When removing refrigerant from a system, either for servicing or decommissioning, it is recommended good practice 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 are 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, **flammable refrigerants**. 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 to the refrigerant supplier 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. When oil is drained from a system, it shall be carried out safely.

Annex EE
(normative)

Pressure tests

EE.1 General

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

A compressor tested for compliance with IEC 60335-2-34 need not be additionally tested.

Compliance is checked by the following tests.

For all tests of Clause 21, if the refrigerant is a blend, the test pressure of EE.4.1 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.4.1, respectively, for the high side and the low side components.

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 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 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 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 pressure developed during abnormal operation (see Clause 19).

EE.4 Pressure test value determined under testing carried out under standstill conditions

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 be subjected to measurement of the maximum pressure developed in the **refrigerating system** under the condition of standstill.

The pressure test value shall be at least three times the maximum 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.4.1 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.5 Fatigue test option for Clauses EE.1 and EE.4.1

EE.5.1 The components shall be subjected to a test at 66,7 % of the test 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.

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 For safety purposes, it is suggested that a non-compressible fluid is used for the test. The fluid fills the sample completely to prevent any significantly 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).

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 hot water heat pumps, the upper pressure shall not be less than 80 % of the maximum 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 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.

Annex FF
(normative)

Leak simulation tests

FF.1 General

A leakage of refrigerant is simulated at the most critical point in the refrigeration system. The method to simulate a leakage at the most critical point 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 charge amount 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).

FF.2 Test methods

FF.2.1 The appliance is modified by introducing a simulated leak through a capillary tube. The leak rate shall be maintained at 25 % ± 5 % of the total appliance charge in 1 min.

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. During a test where the appliance is operating, refrigerant gas injection is started at the same time as the appliance is switched on.

FF.2.3 If a blend refrigerant is used that can fractionate, the test is carried out using the worst fractionated formulation that has the smallest value of *LFL* (lower flammable limit) defined in ANSI/ASHRAE 34-2001.

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 be taken to avoid any condensation occurring in the vessel.

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

The minimum volume (V) is:

$$V = (15 \times m)/LFL,$$

where

V is the minimum volume in m^3 with a ceiling height not less than 2,2 m;

m is the refrigerant charge mass in kg;

LFL is the lower flammable limit in kg/m^3 from Annex BB.

The quantity of gas injected shall be measured with acceptable accuracy. Weighing the bottle is required.