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INTERNATIONAL STANDARD

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Household and similar electrical appliances – Safety – Part 2-34: Particular requirements for motor-compressors

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-34: Particular requirements for motor-compressors

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

This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60335-2-34 edition 5.1 contains the fifth edition (2012-05) [documents 61C/508/FDIS and 61C/517/RVD] and its amendment 1 (2015-05) [documents 61C/597/FDIS and 61C/603/RVD].

In this Redline version, a vertical line in the margin shows where the technical content is modified by amendment 1. Additions and deletions are displayed in red, with deletions being struck through. A separate Final version with all changes accepted is available in this publication.

This part of International Standard IEC 60335 has been prepared by subcommittee 61C: Safety of refrigeration appliances for household and commercial use, of IEC technical committee 61: Safety of household and similar electrical appliances.

The principal changes in this edition as compared with the fourth edition of IEC 60335-2-34 are as follows (minor changes are not listed):

– some notes have been deleted or converted to normative text (1, 6.103, 19.14, 22.7, Figure 101);
– manufacturer must declare the type of motor protection used (5.102, 6.104);
– tests to fault-test **motor-compressors** incorporating **electronic circuits** introduced (19.11.2, AA.5);
– application of the EMP tests clarified (19.11.4);
– testing of contactors and relays associated with **motor-compressors** introduced (19.14);
– tables 101 and 102 updated and corrected;
– running overload test conditions extended (AA.1, AA.2, AA.3, AA.4, AA.5).

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 motor-compressors.

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 smaller roman type.

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

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 the base publication and its amendment 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.

NOTE 4 The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations may need a transitional period following publication of a new, amended or revised IEC publication in which to make products in accordance with the new requirements and to equip themselves for conducting new or revised tests.

It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than 12 months or later than 36 months from the date of publication.

The following differences exist in the countries indicated below:

– 7.1: The locked-rotor current marking is required for some motor-compressors (USA).

– 22.7: Different test pressures are used (Japan, USA).

The contents of the corrigendum of June 2015 of Amendment 1 have been included in this copy.

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 and takes into account the way in which electromagnetic phenomena can affect the safe operation of appliances.

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

If 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.

~~For **motor-compressors**, testing in accordance with this standard is an option and cannot be required as a precondition for testing the complete appliance, for example by reference in Clause 24 of a part 2 of IEC 60335. However, testing of the appliance should be reduced if an incorporated **motor-compressor** including its protection system or control system, if any, complies with this standard.~~

If testing of the **motor-compressor** includes testing in accordance with Annex AA, temperatures of the **motor-compressor** windings, **housing** and other parts related to the **motor-compressor**, such as terminals, internal wiring and insulating materials, are not measured when the complete appliance in which the **motor-compressor** is used is tested.

These requirements apply to sealed (hermetic and semi-hermetic type) **motor-compressors** with their associated starting, cooling capacity control and protection systems, tested separately under the most severe conditions of the refrigerating system operation which, within reasonable limits, could occur in the applications for which they are used.

In particular, the construction detail inspection and locked-rotor testing may be done separately on the **motor-compressor,** thereby eliminating the need for inspection and testing when the **motor-compressor** is applied to many different appliances and factory-built assemblies.

Operational tests may also be conducted on the **motor-compressor** separately in certain circumstances. The specification for this type testing is provided in Annex AA. However, the tests of the existing standards relevant to the given kind of application, such as IEC 60335-2-24 and IEC 60335-2-40, may need to be conducted on the final application and used as the final determination of acceptability.

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-34: Particular requirements for motor-compressors

1 Scope

This clause of Part 1 is replaced by the following.

This International Standard deals with the safety of sealed (hermetic and semi-hermetic type) **motor-compressors**, their protection and control systems, if any, which are intended for use in equipment for household and similar purposes and which conform with the standards applicable to such equipment. It applies to **motor-compressors** tested separately, under the most severe conditions that may be expected to occur in normal use, their **rated voltage** being not more than 250 V for single-phase **motor-compressors** and 480 V for other **motor-compressors**.

This standard also covers

– multi-speed **motor-compressors**, that are **motor-compressors**, the speed of which can be set to different values;

– variable capacity **motor-compressors**, that are **motor-compressors** where the capacity of the compressor is controlled at fixed speeds.

NOTE 101 Examples of equipment which contain **motor-compressors** are

– refrigerators, food freezers and ice makers (IEC 60335-2-24);

– air-conditioners, electric heat pumps and dehumidifiers (IEC 60335-2-40);

– commercial dispensing appliances and vending machines (IEC 60335-2-75);

– factory-built assemblies for transferring heat in applications for refrigerating, air-conditioning or heating purposes or a combination of such purposes.

This standard does not supersede the requirements of standards relevant to the particular appliance in which the **motor-compressor** is used. However, if the **motor-compressor** type used complies with this standard, the tests for the **motor-compressor** specified in the particular appliance standard may not need to be made in the particular appliance or assembly. If the **motor-compressor control system** is associated with the particular appliance control system, additional tests may be necessary on the final appliance.

So far as is practical, this standard deals with the common hazards presented by **motor-compressors** used in appliances which are encountered by all persons in and around the home. However, it does not in general take into account

– the use of appliances by young children or infirm persons without supervision;

– playing with the appliances by young children.

NOTE 102 Attention is drawn to the fact that

– for **motor-compressors** intended to be used in appliances in vehicles or on board ships, additional requirements may be necessary;

– in many countries, additional requirements are specified by the national health authorities, the national authorities responsible for the protection of labour and similar authorities.

NOTE 103 This standard does not apply to

– **motor-compressors** designed exclusively for industrial purposes;

– motor-compressors used in 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).

NOTE 104 If **motor-compressors** for refrigerant R-744 used in appliances with a **transcritical refrigeration system** are equipped with **pressure relief devices**, compliance with the requirements for these devices is checked during the tests on the final appliance.

2 Normative references

This clause of Part 1 is applicable, except as follows.

Addition:

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

IEC 60851-4, *Methods of test for winding wires – Part 4: Chemical properties*

IEC 60851-5:2008, *Winding wires – Test methods – Part 5: Electrical properties*

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

3 Terms and definitions

This clause of Part 1 is applicable, except as follows.

3.101
motor-compressor
appliance consisting of the mechanical mechanism of the compressor and the motor, both of which are enclosed in the same sealed **housing**, with no external shaft seals, and with the motor operating in a refrigerant atmosphere with or without oil

Note 1 to entry: The **housing** may be permanently sealed, such as by welding or brazing (**hermetic motor-compressor**), or may be sealed by gasketted joints (**semi-hermetic motor-compressor**). A terminal box, a terminal box cover, and other electrical components or an electronic control system may be included.

Note 2 to entry: Hereafter, the term **motor-compressor** will be used to designate either a **hermetic motor-compressor** or **semi-hermetic motor-compressor**.

3.102
housing
sealed enclosure for the **motor-compressor**, which contains the compressor mechanism and the motor, and which is subjected to refrigerant pressures

3.103
thermal motor-protector
automatic control, built-in or fitted on a **motor-compressor**, that is specifically intended to protect the **motor-compressor** against over-heating due to running overload and failure to start

Note 1 to entry: This control carries **motor-compressor** current and is sensitive to one or both of the following:

– **motor-compressor** temperature;

– **motor-compressor** current.

Note 2 to entry: The control is capable of being reset (either manually or automatically) when its temperature falls to the reset value.

3.104
motor-compressor protection system
thermal motor protector and associated components, if any, or **protective electronic circuit** fully or partly separate or integrated into the **motor-compressor control system** and which is specifically intended to protect the **motor-compressor** against over-heating due to running overload or failure to start

Note 1 to entry: The control carries **motor-compressor** current and is sensitive to one or both of the following:

– **motor-compressor** temperature;

– **motor-compressor** current.

3.105
motor-compressor control system
system comprising one or more electrical or **electronic components,** or **electronic circuits** that provides at least one of the following:

– **motor-compressor** starting control functions;

– **motor-compressor** cooling capacity control functions

3.106
starting relay
electrically operated control device intended for integration or incorporation into a **motor-compressor** and used within the **motor-compressor** circuit to control the starting of single-phase **motor-compressors**

3.107
application category
back pressure relative to the evaporation temperature range over which the **motor-compressor** operates

Note 1 to entry: For the purpose of this standard, the following classifications of application categories are made relative to the evaporation temperature range:

– low back pressure (LBP): denotes an evaporation temperature range from ~~equal to or less than~~ –35 °C to –15 °C;

– medium back pressure (MBP): denotes an evaporation temperature range from –20 °C to 0 °C;

– high back pressure (HBP): denotes an evaporation temperature range from –5 °C to ~~equal to or greater than~~ +15 °C.

3.108
transcritical refrigeration system
refrigeration system where the pressure in the high pressure side is above the pressure where the vapour and liquid states of the refrigerant can coexist in thermodynamic equilibrium

3.109
design pressure
gauge pressure that has been assigned to a **transcritical refrigeration system**

Note 1 to entry: It is specified for the high pressure side of a refrigeration system.

3 110
pressure relief device
pressure sensing device, intended to reduce pressure automatically when pressures within the refrigeration system exceed the preset pressure of the device

Note 1 to entry: This device has no provisions for setting by the end user.

3.111
two-stage motor-compressor
motor-compressor comprising two compressors and one motor in a single **housing**

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:*

At least one additional sample is required for the tests of clause 19, however further samples may also be provided or are needed.

For the test of 22.7, two samples of the ***housing*** *are required.*

5.7 *Replacement:*

Tests are carried out in an ambient temperature of 20 °C ± 5 °C.

5.8.2 *Addition:*

Motor-compressors *with* ***self-resetting motor-compressor protection systems,*** *and designed for more than one* ***rated voltage,*** *are subjected to the tests of 19.101 and 19.103 at the highest voltage.*

5.10 *Addition:*

For the tests of Clause 19, the additional sample or samples shall be identical in all respects to the test sample, charged with oil, if necessary, and vapour refrigerant. The sample has to be provided with the ***motor-compressor protection system****,* ***starting relay****, start capacitor, run capacitor and control system, if any, as specified by the manufacturer, except that the rotor shall have been locked by the manufacturer.*

The manufacturer or responsible agent shall provide the following information for each type of ***motor-compressor*** *submitted for the tests:*

– *type (synthetic or cellulosic) of winding insulation;*
– *refrigerant identification:*
  a) *for a single component refrigerant, by at least one of the following:*
    - *chemical name;*
    - *chemical formula;*
    - *refrigerant number;*
  b) *for a blended refrigerant, at least one of the following:*
    - *chemical name and nominal proportion of each of the components;*
    - *chemical formula and nominal proportion of each of the components;*
    - *refrigerant number and nominal proportion of each of the components;*
    - *refrigerant number of the refrigerant blend;*
– *types and quantity of oil to be used if the test samples which use oil are not already charged;*
– ***application category*** *or* ***application categories*** *for* ***motor-compressors*** *classified as being tested with Annex AA;*
– *whether a* ***supply cord*** *can be connected directly to terminals on the* ***motor-compressor****;*

– *for **motor-compressors** intended for appliances with a **transcritical refrigeration system**, the test pressure for the high pressure side if higher than the minimum test pressure.*

5.11 *Replacement:*

*For **motor-compressors** which can be used in appliances where the **supply cord** is connected directly to terminals on the **motor-compressor**, the test sample shall be provided with a **supply cord**.*

NOTE 101 Any additional samples required for testing need not be provided with a **supply cord**.

5.101 ***Motor-compressors**, including those with crank-case heaters, are tested as **motor-operated appliances**.*

5.102 *With regard to 6.104, **protective devices** other than the declared device under test shall be disabled during the tests of Annex AA and Clause 19. If multiple **protective devices** are declared, each shall be tested independently.*

5.103 *For cascade systems comprising two or more motor-compressor circuits, each **motor-compressor** circuit is tested separately in the end product. IEC 60335-2-34 is not applicable for the system but each **motor-compressor** can be tested according to this standard.*

6 Classification

This clause of Part 1 is applicable, except as follows.

6.101 **Motor-compressors** not incorporating an **electronic circuit** are classified as being tested with Annex AA or without Annex AA.

Motor-compressors incorporating an **electronic circuit** are classified as being tested with Annex AA.

~~**Motor-compressors** using refrigerant R744 shall not be classified as being tested with Annex AA.~~

Motor-compressors can be classified as being tested with Annex AA only if the **motor-compressor** in combination with the **motor-compressor protection system** or **motor-compressor control system**, if any, can be configured to operate so as to deliver maximum cooling capacity, independently of any input sensors that are only provided as part of the final application.

NOTE **Motor-compressors** classified as being tested without Annex AA and their protection system or control system, if any, are normally subjected to a heating test as a complete system in the final application in accordance with the appropriate appliance standard.

Compliance is checked by

– *the tests of this standard including the tests in Annex AA, for **motor-compressors** tested with Annex AA;*

– *the tests of this standard but not including the tests in Annex AA, for **motor-compressors** tested without Annex AA.*

6.102 **Motor compressors** are classified as being

– intended for direct connection of the appliance **supply cord** to the **motor-compressor** terminals, or

– not intended for direct connection of the appliance **supply cord** to the **motor-compressor** terminals.

NOTE 1 **Motor-compressors** can in both cases be delivered with or without the external components necessary for connection of the **supply cord**.

NOTE 2 **Motor-compressors** intended for direct connection of the appliance **supply cord** to their terminals can also be used without the **supply cord** being connected directly to their terminals.

NOTE 3 If the **motor-compressor** is used without the relevant components or with components different from those specified by the manufacturer, additional testing in accordance with the appropriate appliance standard can be necessary.

Compliance is checked by inspection and by the relevant tests.

6.103 **Motor-compressors** are classified as being protected by **protective electronic circuits** or not being protected by **protective electronic circuits**.

This does not preclude the **protective electronic circuits** being provided in the end product, in which case many of the tests of this standard shall be conducted on the end product.

Compliance is checked by inspection and by the relevant tests.

6.104 *The **motor-compressor** manufacturer shall declare the means of motor protection, **thermal motor protector**, impedance protection, **protective electronic circuit**, or a combination of the above.*

Compliance is checked by inspection and by the relevant tests.

6.105 Motor-compressors using refrigerant R744 shall be classified as used in a **transcritical refrigeration system** or in a non-**transcritical refrigeration system**.

Compliance is checked by inspection and by the relevant tests.

7 Marking and instructions

This clause of Part 1 is applicable, except as follows.

7.1 *Modification:*

The **rated power input** or **rated current** need not be marked.

Addition:

Motor-compressors suitable for use with a flammable refrigerant shall be marked with symbol ISO 7010 W021.

7.5 Not applicable.

7.6 *Addition:*

Symbol ISO 7010 W021 Warning; flammable materials

7.7 Not applicable.

7.12 Not applicable, except 7.12.1 which is applicable.

7.13 Not applicable.

7.101 Refrigerants that can be used with the **motor-compressor** shall be listed in the instructions.

Compliance is checked by inspection.

8 Protection against access to live parts

This clause of Part 1 is applicable.

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 not applicable.

11 Heating

This clause of Part 1 is not applicable.

NOTE 101 For **motor-compressors**, this clause of Part 1 can be covered by Annex AA.

12 Void

13 Leakage current and electric strength at operating temperature

This clause of Part 1 is not applicable, except 13.3 as required by 19.104.

14 Transient overvoltages

This clause of Part 1 is applicable.

15 Moisture resistance

This clause of Part 1 is applicable, except as follows.

15.3 *Addition:*

NOTE 101 **Motor-compressors** with glass-insulated terminals and without any external control devices, protectors or other components need not be tested.

16 Leakage current and electric strength

This clause of Part 1 is applicable.

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:*

Replace the test specification by the following:

Motor-compressors *are submitted to the tests of 19.14, 19.15, 19.101, 19.102, 19.103 and, additionally, if so required by the classification of 6.101, to the tests specified in Annex AA.*

Motor-compressors *incorporating* ***electronic circuits*** *are also subjected to the tests of 19.11 and 19.12.*

Only one abnormal condition is simulated each time.

Compliance with the tests of 19.11 and 19.12 is checked as described in 19.13. Compliance with the tests of 19.101, 19.102 and 19.103 is checked as described in 19.104. Compliance with the tests of Annex AA is checked as described in Annex AA.

19.2 to **19.10** Not applicable.

19.11.2 *Addition:*

For simulation of the fault conditions, a ***motor-compressor*** *incorporating an* ***electronic circuit*** *is connected to the substitute refrigeration circuit of Figure AA.1 and operated under the conditions given in Clause AA.5. The condensing temperature applied being 5 K lower than that which caused the* ***motor-compressor protective electronic circuit*** *to operate or the* ***motor-compressor*** *to stall during the test of Clause AA.5.*

19.11.3 *Replacement:*

If the ***motor-compressor*** *is classified as being protected by a* ***protective electronic circuit*** *and if this* ***protective electronic circuit*** *operates to ensure compliance with Clause 19 and Annex AA, the tests of 19.101, 19.102, 19.103 and Annex AA are repeated with a single fault simulated, as indicated in a) to g) of 19.11.2.*

However, the test of Annex AA is not repeated if during the test of Annex AA, for ***motor-compressors*** *classified as being tested with Annex AA, the* ***motor-compressor protection system*** *did not operate. The test of Annex AA is also not repeated on* ***motor-compressors*** *that are classified as being tested without Annex AA.*

19.11.4 *Addition:*

If the tests have to be carried out, they shall be carried out in the end product application.

NOTE 101 The application of these tests in this part 2 is not mandatory since they are conducted in the end product application.

19.13 *Addition:*

If the ***motor-compressor*** *is intended to use flammable refrigerants, and if during the tests of 19.11.2 and 19.11.3 any electrical component produced sparks or arcs, this shall be reported*

*unless the component was an **intentionally weak part** or a **non-self-resetting protective device**.*

19.14 *Replacement:*

***Motor-compressors** are operated under the conditions of Clause AA.1. Any contactor or relay contact that operates under the conditions of Clause AA.1 is short-circuited.*

If a relay or contactor with more than one contact is used, all contacts are short-circuited at the same time.

*Any relay or contactor which operates only in order to ensure that the **motor-compressor** is energized for normal use and that does not otherwise operate in normal use is not short-circuited.*

If more than one relay or contactor operates in Clause AA.1, each such relay or contactor is short-circuited in turn.

*For **motor-compressors** that use alternate start capacitors, the test shall be carried out using each alternate start capacitor in turn.*

*The test is only performed on **motor-compressors** classified as being tested with Annex AA.*

NOTE 1 For **motor-compressors** not classified as being tested with Annex AA, this test will be performed on the final product.

NOTE 2 If the **motor-compressor** has several modes of operation, the tests are carried out with the **motor-compressor** operating in each mode, if necessary.

19.101 *The **motor-compressor** and **motor-compressor protection system**, together with all their associated components which operate under locked-rotor conditions, are connected in the circuit shown in Figure 101 and supplied with **rated voltage** as specified in 5.8.2.*

NOTE 1 The associated components which comply with the requirements in Clause 24 are not evaluated by this test.

*For **motor-compressors** with a **non-self-resetting thermal motor-compressor protection system**, the **motor-compressor** is operated until a sufficient number of operations have been made to ensure that continuous automatic recycling does not occur. The number of operations should, however, not be less than three and should be performed as rapidly as possible with a minimum delay of 6 s.*

*A longer off time is permitted if a delay feature longer than 6 s is part of the **protection system** or **control system**.*

*All electromechnical components of the **protection system** shall be tested individually for 50 operations in total with the **motor-compressor** or with a load corresponding to the actual **motor-compressor** or a higher load.*

*For **motor-compressors** with a **self-resetting motor-compressor protection system**, the **motor-compressor protection system** is allowed to cycle continuously for a period of 15 days or for at least 2 000 cycles, whichever is the longer.*

***Motor-compressors** without a **motor-compressor protection system** and only protected by the impedance of the windings, are connected in the circuit shown in Figure 101 and supplied with rated voltage. If a **motor-compressor** is designed for more than one rated voltage it is tested at the highest voltage.*

*At the conclusion of the first 72 h of the locked-rotor test, the **motor-compressor** is subjected to the electric strength test as specified in 16.3.*

*For **motor-compressors** with a **self-resetting motor-compressor protection system,** if 2 000 cycles of the protection system have not been performed by the end of the 15-day period, the test may be terminated provided the following conditions are met:*

– *the **housing** temperature is recorded on the 12th and 15th days. If, during this three day period, the temperature has not increased by more than 5 K, the test can be terminated. If the temperature has increased by more than 5 K, the test is to be continued until the temperature has not increased by more than 5 K over a period of three consecutive days or for at least 2 000 cycles of the **motor-compressor protection system**, whichever occurs first;*

– *the components in the circuit comply with the requirements of clause 24 using at least the current and a power factor not exceeding that measured during the test.*

NOTE 2 If a given **motor-compressor**, **self-resetting motor-compressor protection system combination** is intended for use with more than one refrigerant, only one 15 day test is required, the choice of the refrigerant being made by the **motor-compressor** manufacturer.

NOTE 3 These test procedures can be modified, if necessary, to evaluate **motor-compressor protection systems** which incorporate special or unique features.

***Motor-compressors** with a **self-resetting motor-compressor protection system** and designed for more than one **rated voltage** are also tested at the lowest voltage for 3 h.*

NOTE 4 A separate sample can be used for the test at the lowest voltage.

*For **motor-compressors** where the design of the **protection system** or **control system** is such that the windings are de-energized permanently, the **motor-compressor** and **motor-compressor protection system** (if any), together with all their associated components which operate under locked-rotor conditions, are re-energized. This procedure is repeated as rapidly as possible until 10 operations have been performed, with a minimum off time of 6 s. A longer off time is permitted if a delay feature longer than 6 s is part of the **protection system** or **control system**.*

*If the **motor-compressor** is designed for more than one rated voltage, the test is performed at all rated voltages.*

*If the **motor-compressor** is designed for a voltage range, the test is performed at the upper and lower voltage limit.*

***Motor-compressors** without a **motor-compressor protection system** are left energized as described above for 15 days. The **housing** temperature is recorded on the 12th and 15th days. If during these three days, the temperature has not increased by more than 5 K, the test can be terminated.*

19.102 *The test of 19.101 is repeated for one operation of a **non-self-resetting motor-compressor protection system** or 3 h minimum for **self-resetting motor-compressor protection system** under the following conditions:*

– *with start and run capacitors open-circuited one at a time;*

– *with start and run capacitors short-circuited one at a time, unless they have been tested and shown to comply with the requirements for protection class P2 capacitors of IEC 60252-1.*

NOTE 1 The test with the capacitors open-circuited need not be conducted for **motor-compressors** where the open-circuited capacitors remove the start winding from the circuits.

NOTE 2 For **motor-compressors** with a **self-resetting motor-compressor protection system** and which are designed for more than one **rated voltage**, it is not necessary to repeat the test at the lowest voltage.

NOTE 3 This test can be performed on separate samples.

19.103 *Three-phase **motor-compressors** and the **motor-compressor protection systems**, together with all their associated components which operate under locked-rotor conditions, are connected in a circuit similar to that shown in Figure 101, the circuit being appropriately modified for three-phase **motor-compressors**. They are supplied with **rated voltage** but with one phase to the **motor-compressor** disconnected during the following periods:*

– *for **motor-compressors** with a **self-resetting motor-compressor protection system**, for 3 h;*

– *for **motor-compressors** with a **non-self-resetting motor-compressor protection system**, until the first operation of the **motor-compressor protection system**.*

– *for **motor-compressors** without a **motor-compressor protection system** for 3 h.*

NOTE This test can be carried out on a separate sample.

19.104 *During the tests of 19.101, 19.102 and 19.103,*

– *the **motor-compressor protection system** shall be able to operate;*

– *the temperature of the **housing** and the temperature of the accessible surfaces of associated components shall not exceed 150 °C;*

– *the residual current device shown in Figure 101 shall not operate;*

– *the **motor-compressor**, its associated **starting relay** and **motor-compressor protection system** shall not emit flames, sparks or molten metal.*

At the conclusion of the tests of 19.101, 19.103 and the test of 19.102 that is carried out with start and run capacitors open-circuited,

– *enclosures shall not have deformed to such an extent as to impair compliance with clause 29;*

– *the **motor-compressor protection system** shall be able to operate;*

– *the **motor-compressor** shall withstand*

- *the leakage current test as specified in 16.2, the test voltage being applied between the windings and the **housing**;*
- *the electric strength test of 13.3 of Part 1.*

If the test of 19.102 is carried out with start and run capacitors short-circuited one at a time, then at the conclusion of this test,

– *enclosures shall not have deformed to such an extent as to impair compliance with Clause 29;*

– *the **motor-compressor** shall withstand*

- *the leakage current test as specified in 16.2, the test voltage being applied between the windings and the **housing**;*
- *the electric strength test of 13.3 of Part 1;*

– *the **motor-compressor protection system** shall be able to operate or it shall remain permanently open-circuited.*

*If the **motor-compressor protection system** remains permanently open-circuited, the test of 19.102 with start and run capacitors short-circuited shall be repeated on three additional samples and all three additional samples shall remain permanently open-circuited at the conclusion of the test.*

NOTE The test can be repeated on three new **motor-compressors** or by replacing, in the **motor-compressor** originally tested, the **motor-compressor protection system** with one of the same type.

19.105 Three-phase **motor-compressors** shall be adequately protected against primary single-phase failure.

NOTE 1 Primary single-phase failure means that one of the three incoming lines to the primary of the transformer supplying the **motor-compressor** is disconnected.

Compliance is checked by the following test.

*The **motor-compressor** is supplied from a star-delta or delta-star connected transformer with a line voltage ratio such that the output voltage is equal to the **rated voltage** of the **motor-compressor**. The transformer is supplied with an input voltage such that the output voltage is equal to the **rated voltage** of the **motor-compressor**. One phase of the supply to the input windings of the transformer is then disconnected so that maximum current flows in an unprotected winding of the **motor-compressor**.*

The test is continued for the following periods:

– *24 h, for **motor-compressors** with a **self-resetting motor-compressor protection system**;*
– *until the first operation of the protective system, for **motor-compressors** with a **non-self-resetting motor-compressor protection system**.*

***Motor-compressors** designed for more than one **rated voltage** are tested at each voltage.*

*However, **motor-compressors** with a **self-resetting motor-compressor protection system** and designed for more than one **rated voltage** are tested at the highest voltage for 24 h and at the lowest voltage for 3 h.*

NOTE 2 Separate samples can be used in testing **motor-compressors** designed for more than one **rated voltage**, at each of their **rated voltages**.

During the test,

– *the temperature of the **housing** and the temperature of the accessible surfaces of associated components shall not exceed 150 °C;*
– *the **motor-compressor** windings shall not be damaged;*
– *the **motor-compressor** and **motor-compressor protection system** shall not emit flames, sparks or molten metal.*

NOTE 3 **Motor-compressor** windings are considered damaged if the windings open circuit or if the **motor-compressor** does not comply with the electric strength tests specifications. **Motor-compressors** with a **self-resetting motor-compressor protection system** are also considered damaged if there is a change in the relative distribution of currents during the test, or if currents measured at the conclusion of the test vary by more than 5 % from currents measured 3 h after the start of the test or on the first closure of the protective system following these 3 h.

*Immediately following this test, the **motor-compressor** shall withstand the electric strength test of 16.3.*

*A three-phase **motor-compressor** is considered to meet the requirement for primary single-phase failure protection without tests other than those specified in 19.101, 19.102 and 19.103, if it is protected by one of the following devices:*

– *an overcurrent device, protecting each phase of its supply and which is provided with the **motor-compressor** or the rating of which is specified by the **motor-compressor** manufacturer;*
– *a **motor-compressor protection system**, responsive to motor current, installed symmetrically at the centre point of a star-connected **motor-compressor** and which simultaneously opens at least two windings;*
– *a **motor-compressor protection system**, located in each winding of the **motor-compressor**, which activates pilot duty contacts controlling the supply to the coil of*

*the **motor-compressor** supply contactor and which is responsive to at least one of the following:*

- ***motor-compressor** current,*
- ***motor-compressor** temperature.*

20 Stability and mechanical hazards

This clause of Part 1 is applicable.

21 Mechanical strength

This clause of Part 1 is applicable.

22 Construction

This clause of Part 1 is applicable, except as follows.

22.2 Not applicable.

22.5 Not applicable.

22.7 *Replacement:*

Housings shall withstand the pressure expected in normal use.

Compliance is checked by the following tests.

*A **housing** which is exposed to high side pressure shall be subjected to a pressure equal to:*

– *for non **transcritical refrigeration systems**, a minimum of 3,5 times the saturated vapour pressure of the refrigerant at 70 °C, rounded up to the next 0,5 MPa (5 bar).*

– *for R-744 non-**transcritical refrigeration systems**, a minimum of 3,5 times the saturated vapour pressure of the refrigerant at 27 °C, rounded up to the next 0,5 MPa (5 bar).*

NOTE 101 Example of test pressure calculation for R-22 (subcritical):

Saturated vapour pressure at 70 °C (gauge with respect to atmospheric pressure at STP) = 2,89 MPa (28,9 bar)

Test pressure = 3,5 × 2,89 MPa (28,9 bar)

= 10,1 MPa (101 bar)

= 10,5 MPa (105 bar) when rounded up to the next 0,5 MPa (5 bar).

– *for **transcritical refrigeration systems**, 3 times the **design pressure** but not less than the minimum test pressure as required in Table 101.*

– *if the **motor-compressor** employs a bypass valve, a minimum of 3 times the maximum high side pressure, but not less than the minimum test pressure as required in Table 101.*

The test values for some refrigerants are given in Table 101. The values may, however, not be high enough for some applications.

Table 101 – Minimum high side test pressures

Refrigerant formulae	Refrigerant number	Test pressure MPa	(bar)
Non-transcritical			
CCl_2F_2	R-12	6,0	(60)
CF_3CH_2F	R-134a	6,5	(65)
$CHClF_2$	R-22	10,5	(105)
$CH(CH_3)_3$	R-600a	3,5	(35)
by weight 73,8 % R-12 + 26,2 % R-152a	R-500	10,0	(100)
by weight 48,8 % R-22 + 51,2 % R-115	R-502	10,5	(105)
by weight 44 % R-125 + 52 % R-143a + 4 % R-134a	R-404A	10,0	(100)
by weight 50 % R-125 + 50 % R-143a	R-507A	11,0	(110)
by weight 25 % R-125 + 52 % R-134a + 23 % R-32	R-407C	10,5	(105)
by weight 50 % R-125 + 50 % R-32	R-410A	15,0	(150)
Transcritical			
CO_2	R-744	42	(420)
Non-transcritical			
CO_2	R-744	23,0	(230)

*A **housing** which is exposed only to low side pressure shall, for both subcritical and transcritical applications, be subjected to a pressure equal to five times the saturated vapour pressure of the refrigerant at 20 °C or equal to 2,5 MPa (25 bar) whichever is higher, rounded up to the next 0,2 MPa (2 bar).*

*A **housing** which is exposed only to low side pressure in R-744 non-**transcritical refrigeration systems** shall be subjected to a pressure equal to a minimum of 5 times the saturated vapor pressure of the refrigerant at − 6,5 °C or equal to 13,5 MPa (135 bar), whichever is higher, rounded up to the next 0,2 MPa (2 bar).*

*A **housing** which is exposed only to low side pressure in **transcritical refrigeration systems** shall be subjected to a pressure equal to a minimum of 5 times the **design pressure** but not less than the minimum test pressure as required by Table 102.*

*For a **motor-compressor** employing a bypass valve, the **housing** which is exposed only to low side pressure shall be subjected to a pressure equal to 3 times the maximum low side pressure, but not less than the minimum test pressure as required in Table 102.*

The test values for some refrigerants are given in Table 102. The values may, however, not be high enough for some applications.

NOTE 102 Example of test pressure calculation for R-22 (subcritical):

Saturated vapour pressure at 20 °C (gauge with respect to atmospheric pressure at STP) = 0,81 MPa (8,1 bar)

Test pressure = 5 × 0,81 MPa (8,1 bar)

= 4,05 MPa (40,5 bar)

= 4,2 MPa (42 bar) when rounded up to the next 0,2 MPa (2 bar).

Table 102 – Minimum low side test pressures

Refrigerant formulae	Refrigerant number	Test pressure MPa	(bar)
Non-transcritical			
CCl_2F_2	R-12	2,5	(25)
CF_3CH_2F	R-134a	2,5	(25)
$CHClF_2$	R-22	4,2	(42)
$CH(CH_3)_3$	R-600a	2,5	(25)
by weight 73,8 % R-12 + 26,2 % R-152a	R-500	2,9	(29)
by weight 48,8 % R-22 + 51,2 % R-115	R-502	4,5	(45)
by weight 44 % R-125 + 52 % R-143a + 4 % R-134a	R-404A	5,0	(50)
by weight 50 % R-125 + 50 % R-143a	R-507A	5,5	(55)
by weight 25 % R-125 + 52 % R-134a + 23 % R-32	R-407C	4,0	(40)
by weight 50 % R-125 + 50 % R-32	R-410A	7,0	(70)
Transcritical			
CO_2	R-744	28,6	(286)
Non-transcritical			
CO_2	R-744	14,0	(140)

NOTE 103 Further information relating to refrigerant number designations can be obtained from ISO 817.

For refrigerant blends, the saturated vapour pressure is taken as the pressure at the dew point temperature.

*For two stage **motor-compressors** with direct discharge from the second stage, the **housing** is considered to be exposed to low side pressure.*

*For two stage **motor-compressors** without direct discharge from the second stage, the **housing** is considered to be exposed to high side pressure.*

The test shall be carried out on two samples. 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. This pressure is maintained for 1 min during which time the sample shall not leak except as indicated below.

*Where gaskets are employed for sealing the **housing** of a **semi-hermetic motor-compressor**, leakage at gaskets is not considered as a failure, provided the leakage occurs at a pressure greater than 40 % of the required test pressure.*

If a leakage occurs, the test has to be repeated on a sample specially prepared by the manufacturer to avoid leakage at the gasket.

*For a **semi-hermetic motor-compressor** employing a bypass valve which relieves high side pressure into the low side at a predetermined pressure differential, the **housing** shall be capable of withstanding the required test pressure even though leakage occurs at gaskets.*

NOTE 104 All pressures are gauge pressures.

22.9 *Addition:*

Insulating materials used within the **housing** shall be compatible with the refrigerant and oil used.

~~NOTE 101 Compliance with this requirement can be proven by an appropriate certificate provided by the manufacturer of the **motor-compressor**.~~

*For the types of refrigerant and types of oil for which the **motor-compressor** is intended to be used, compliance of winding wire insulation shall be checked by the tests detailed in Annex BB or **motor-compressors** that do not use oil by test 16 in IEC 60851-4 for resistance to refrigerants.*

For test 16 in IEC 60851-4, the percentage of extractable matter shall not exceed 0,5 %. The breakdown voltage shall be at least 75 % of the minimum specified value.

*For the types of refrigerant and types of oil for which the **motor-compressor** is intended to be used, compliance of tie cords and insulation materials other than winding wire insulation shall be checked by the tests detailed in Annex CC.*

22.14 Not applicable.

22.21 *Addition:*

NOTE 101 The requirement is applicable only to external parts of the **motor-compressor**.

22.101 Where a **motor-compressor** used in a **transcritical refrigeration system** includes a **pressure relief device** in the high side or discharge piping of the **motor-compressor**, there shall be no other shut off devices or system components except piping located between the **motor-compressor** and **pressure relief device** which could introduce a pressure drop.

NOTE The required **pressure relief device** could be installed by either the **motor-compressor** manufacturer or the appliance manufacturer.

Compliance is checked by inspection.

23 Internal wiring

This clause of Part 1 is applicable, except as follows.

23.8 *Addition:*

NOTE 101 This does not apply to wiring inside the **housing**.

24 Components

This clause of Part 1 is applicable, except as follows.

24.1.4 *Addition:*

– ***starting relay***	*100 000*
– ***self-resetting thermal motor-protectors*** *for* ***motor-compressors****	*2 000*
– ***non-self resetting thermal motor-protectors*** *for* ***motor-compressors***	*50*

* 2 000 or the number of operations during the 15 day locked-rotor test of 19.101, whichever is the greater.

24.101 In **motor-compressors** that employ flammable refrigerants, components that may arc or spark during **normal operation** of the end product shall comply with the requirements of IEC 60079-15, as modified by Annex DD, for group IIA gases or the refrigerant used. This requirement is not applicable to components within the **housing**.

Compliance is checked by inspection and the appropriate tests of IEC 60079-15.

25 Supply connection and external flexible cords

This clause of Part 1 is applicable, except as follows, only if so required by the classification of 6.102.

25.1 *Addition:*

– a set of terminals allowing the connection of a **supply cord**.

25.7 Not applicable.

26 Terminals for external conductors

This clause of Part 1 is applicable only if so required by the classification of 6.102.

27 Provision for earthing

This clause of Part 1 is applicable, except as follows.

27.1 *Addition:*

An earthing terminal is required only if the **motor-compressor** is classified in accordance with 6.102 as being intended for direct connection of the appliance **supply cord** to the **motor-compressor** terminals.

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.

29.1 *Addition:*

Except as specified in 29.1.1 and 29.1.4, **clearances** less than those specified in Table 16 are not allowed for **basic insulation** and **functional insulation** inside the **housing**.

29.1.1 *Addition:*

Clearances inside the **housing** shall not be less than 1,0 mm for a rated impulse voltage of 1 500 V.

29.1.4 *Addition:*

Clearances inside the **housing** are reduced by 0,5 mm for rated impulse voltages of 2 500 V or more. Between winding wires and winding leads for motors or **thermal motor protectors**, no minimum **clearance** is specified.

29.2 *Addition:*

Pollution degree 1 applies inside the **housing**.

29.2.1 *Modification:*

Add the following to Note 2 in Table 17:

This does not apply to glass insulated terminals where corrosion protection extends over the glass.

29.2.4 *Modification:*

Add the following to Note 2 in Table 18:

This does not apply to glass insulated terminals where corrosion protection extends over the glass.

30 Resistance to heat and fire

This clause of Part 1 is applicable only to non-metallic and insulating materials which are outside the **housing** except as follows.

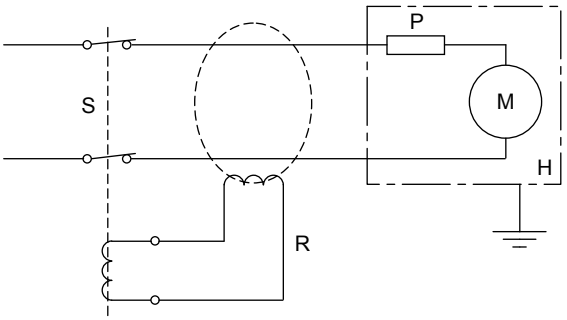
30.2.2 Not applicable.

31 Resistance to rusting

This clause of Part 1 is applicable only to parts which are outside the **housing**.

32 Radiation, toxicity and similar hazards

This clause of Part 1 is not applicable.



Key

S	Supply
H	**Housing**
R	Residual current device that can detect a.c. or a.c. with d.c. components, max. $I_{\Delta n}$ = 30 mA r.m.s. or d.c. max. $I_{\Delta n}$ = 30 mA
P	**Motor-compressor protection system** (external or internal)
M	**Motor-compressor**

Figure 101 – Supply circuit for the locked-rotor test of a single-phase motor-compressor

Annexes

The annexes of Part 1 are applicable, except as follows:

Annex C
(normative)

Ageing test on motors

This annex of Part 1 is not applicable.

Annex D
(normative)

Thermal motor protectors

This annex of Part 1 is not applicable.

Annex AA
(normative)

Running overload tests for motor-compressors classified as tested with Annex AA

AA.1 Unless otherwise stated, the tests in this annex are only applied if the **motor-compressor** is classified as being tested with Annex AA according to 6.101.

Excluding starting current, the maximum value of the current averaged over any 5 min period is recorded. The interval between current measurements shall not exceed 30 s. The starting current is considered to be excluded if the first current measurement is made approximately 1 min after starting.

NOTE 1 The current is recorded to aid in checking reproducibility of test results.

*Before testing in accordance with this annex is started, it shall be verified that the **motor-compressor** is in working order by applying the test of 16.3 and then by operating it in a substitute refrigeration circuit*

– *under the conditions specified in Table AA.1 but at **rated voltage**; or*

– *the maximum load – maximum cooling conditions specified in Table AA.2;*

as appropriate for a period of not less than 2 h.

*If the **motor-compressor protection system** or **motor-compressor control system** contains an **electronic circuit** the tests in Clauses AA.4 and AA.5 are to be conducted, otherwise, the tests in Clauses AA.2 and AA.3 are to be conducted. If two stage **motor-compressors** are to be tested in accordance with Clauses AA.2 and AA.3, they have to be tested under the most onerous conditions of operation.*

NOTE ~~1~~ 2 For most applications of **motor-compressors**, it is possible to simulate an actual refrigerant circuit and its corresponding effect on the **motor-compressor** operation, by the use of a calorimeter or substitute refrigeration circuit (see Figure AA.1 for such a typical circuit). By so doing, it is possible to determine the maximum motor temperature that would be attained with a given **motor-compressor/motor-compressor protection system** combination.

NOTE ~~2~~ 3 The temperatures of the **motor-compressor** are affected by the varying parameters of suction pressure, discharge pressure, return gas temperature, **motor-compressor** ambient temperature and amount of air movement over the **motor-compressor**. It is generally possible to simulate the maximum conditions that will be imposed by a general class of appliances, with a calorimeter or substitute refrigeration circuit.

NOTE ~~3~~ 4 On those refrigerator and freezer applications that employ additional cooling means, such as an injection cooler or an oil cooler tube in the **motor-compressor**, to reduce the motor temperature in cases where the temperature limits specified in Clause AA.2 would otherwise be exceeded, tests in the actual application can be required, as the exact effect of the additional cooling means may not be able to be simulated.

NOTE ~~4~~ 5 As the **motor-compressor protection system** is the motor temperature limiting device, measuring the motor temperature at the ultimate trip point is all that is required to establish the maximum motor winding temperature.

NOTE ~~5~~ 6 If the motor winding temperature of the **motor-compressor** does not exceed the maximum value specified in Clause AA.3 and Clause AA.5 when tested in accordance with its **application category** as indicated in Table AA.1, the **motor-compressor**/ **motor-compressor protection system** combination is considered as meeting the requirements for motor winding temperatures in related standards, such as IEC 60335-2-11, IEC 60335-2-24, IEC 60335-2-40, IEC 60335-2-75 and IEC 60335-2-89.

NOTE ~~6~~ 7 Fixed speed **motor-compressors** that are tested in accordance with Clauses AA.4 and AA.5 need only be tested at the fixed speed since there are no minimum and maximum cooling conditions.

AA.2 *The **motor-compressor** including the **motor-compressor protection system** or **motor-compressor control system**, if any, is connected to the substitute refrigeration circuit of Figure AA.1 and operated under the appropriate conditions given in Table AA.1 for tests 1 and 2. However, for R-744 refrigerant intended for use in a **transcritical refrigeration system**, for all tests the maximum operating discharge pressure is 12 MPa and the return gas temperature is +25 °C. The tests are continued until steady conditions are reached. If the **motor-compressor** cooling capacity is variable, the tests are carried out at maximum and minimum cooling conditions.*

NOTE 1 Special arrangements for the **motor-compressor control system** can be needed in order to obtain the maximum value of the cooling capacity.

NOTE 2 Steady conditions are considered to be obtained when three successive readings of the temperature, taken at approximately 10 min intervals, at the same point of any operating cycle, do not differ by more than 1 K.

Table AA.1 – Substitute refrigeration circuit conditions for operating under running overload conditions

Test number	Applied voltage	Back pressure application category	Evaporation temperature °C	Condensation temperature °C	Motor-compressor ambient temperature °C	Return gas temperature °C
1	1,06 **Rated voltage**	Low back pressure – max. cooling	–15	+65	+43	+43
1	1,06 **Rated voltage**	Low back pressure – min. cooling	–15	+65	+43	+43
1	1,06 **Rated voltage**	Medium back pressure – max. cooling	0	+65	+43	+25
1	1,06 **Rated voltage**	Medium back pressure – min. cooling	0	+65	+43	+25
1	1,06 **Rated voltage**	High back pressure – max. cooling	+~~12~~ 15	+65	+43	+25
1	1,06 **Rated voltage**	High back pressure – min. cooling	+~~12~~ 15	+65	+43	+25
2	0,94 **Rated voltage**	Low back pressure – max. cooling	–15	+65	+43	+43
2	0,94 **Rated voltage**	Low back pressure – min. cooling	–15	+65	+43	+43
2	0,94 **Rated voltage**	Medium back pressure – max. cooling	0	+65	+43	+25
2	0,94 **Rated voltage**	Medium back pressure – min. cooling	0	+65	+43	+25
2	0,94 **Rated voltage**	High back pressure – max. cooling	+~~12~~ 15	+65	+43	+25
2	0,94 **Rated voltage**	High back pressure – min. cooling	+~~12~~ 15	+65	+43	+25
3	0,85 **Rated voltage**	Low back pressure – max. cooling	–15	+65	+43	+43
3	0,85 **Rated voltage**	Low back pressure – min. cooling	–15	+65	+43	+43
3	0,85 **Rated voltage**	Medium back pressure – max. cooling	0	+65	+43	+25
3	0,85 **Rated voltage**	Medium back pressure – min. cooling	0	+65	+43	+25
3	0,85 **Rated voltage**	High back pressure – max. cooling	+~~12~~ 15	+65	+43	+25
3	0,85 **Rated voltage**	High back pressure – min. cooling	+~~12~~ 15	+65	+43	+25

NOTE For R-744 refrigerant intended for use in a non-**transcritical refrigeration system**, for all tests the evaporation temperature is –15 °C, the condensation temperature is +20 °C , the **motor-compressor** ambient temperature is +43 °C and the return gas temperature is +2 °C.

NOTE 3 The tolerances on the temperatures in Table AA.1 are ±2 K for the **motor-compressor** ambient temperature, condensation and return gas temperatures, and ±1 K for the evaporation temperature.

NOTE 4 For some **motor-compressors**, an injection cooler or an oil cooler and air flow over the **motor-compressor** can be required as recommended by the **motor-compressor** manufacturer.

NOTE 5 The evaporation and condensation temperatures relate to the corresponding saturated vapour pressures of the refrigerant in use, and are measured by means of the pressure gauges as "suction" and "discharge" respectively in Figure AA.1. For refrigerant blends, the saturated vapour pressure is taken as the pressure at the dew point temperature.

NOTE 6 The return gas temperature is measured by means of a thermocouple, situated in the suction line at point A as shown in Figure AA.1.

NOTE 7 The test is carried out at a 43 ºC ambient temperature so as to produce an overload on the **motor-compressor**. It is not intended that this be the reference ambient temperature for the temperature rises given in Table 3 of Part 1.

During tests 1 and 2,

– *the temperature rises are measured and shall not exceed the values given in the Table 3 of Part 1 reduced by 7 K;*
– *the **motor-compressor protection system** shall not operate to disconnect the **motor-compressor** from the supply;*
– *the temperature of the **housing** and the temperature of the accessible surfaces of associated components shall not exceed 150 °C.*

NOTE 8 The requirements in Table 3, regarding winding temperatures of the different insulation classes are not applicable to the windings of **motor-compressors**.

AA.3 *Immediately after the tests of Clause AA.2, the **motor-compressor** including the **motor-compressor protection system** or **motor-compressor control system**, if any, is operated under the appropriate conditions given in Table AA.1 for test 3 so as to cause the **motor-compressor protection system** to operate or to reach steady conditions with the **motor-compressor** in the stalled or running condition.*

*During test 3, if the **motor-compressor protection system** does not operate, the voltage is reduced in steps of 4 % ±1 % of the **rated voltage**, at a rate of approximately 2 V/min, until steady conditions are reached at each step. This procedure is continued until one of the following conditions occurs:*

– *the **motor-compressor** protection system operates;*
– *the **motor-compressor** stalls and steady conditions are reached.*

NOTE 1 If the cooling capacity is influenced by the adjustment of the voltage, the **motor-compressor control system** is not adjusted during the test in an attempt to maintain the cooling capacity as it was when the test was started.

*In neither of these conditions shall the **motor-compressor** winding temperature exceed 160 °C for **motor-compressors** with synthetic insulation and 150 °C for **motor-compressors** with cellulosic insulation.*

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

If the **motor-compressor** is of the single-phase type with an internally mounted **motor-compressor protection system**, the combined resistance of the main winding and start winding, in series, is used. If the **motor-compressor** is of the three-phase type with an internally mounted **motor-compressor protection system**, it will be necessary to first establish the trip point then re-run the test and measure the resistance after shut-down, just prior to the **motor-compressor protection system** tripping. A continuous resistance recording technique may be used if the temperatures correlate properly with those obtained by the shut-down resistance method.

AA.4 *The **motor-compressor** including the **motor-compressor protection system** and **motor-compressor control system**, if any, is connected to the substitute refrigeration circuit of Figure AA.1 and operated under the appropriate conditions given in Table AA.2 for each of tests 4, 5, 6 and 7. However, for R-744 refrigerant intended for use in a **transcritical refrigeration system**, for all tests the maximum operating discharge pressure is 12 MPa and for tests 4 and 6 the return gas temperature is +25 °C. The tests are continued until steady conditions are reached.*

Table AA.2 – Substitute refrigeration circuit conditions for operating under maximum and minimum load conditions

Test number	Applied voltage	Back pressure application category	Evaporation temperature °C	Condensation temperature °C	Motor-compressor ambient temperature °C	Return gas temperature °C
4	**Rated voltage**	Low back pressure – max. load – max. cooling	–15	+65	+43	+43
5	**Rated voltage**	Low back pressure – min. load – max. cooling	~~–40~~ 35	+49	+43	+25
6	**Rated voltage**	Low back pressure – max. load – min. cooling	–15	+65	+43	+43
7	**Rated voltage**	Low back pressure – min. load – min. cooling	~~–40~~ 35	+49	+43	+25
4	**Rated voltage**	Medium back pressure – max. load – max. cooling	0	+65	+43	+25
5	**Rated voltage**	Medium back pressure – min. load – max. cooling	~~–25~~ 20	+55	+43	+25
6	**Rated voltage**	Medium back pressure – max. load – min. cooling	0	+65	+43	+25
7	**Rated voltage**	Medium back pressure – min. load – min. cooling	~~–25~~ 20	+55	+43	+25
4	**Rated voltage**	High back pressure – max. load – max. cooling	~~+12~~ 15	+65	+43	+25
5	**Rated voltage**	High back pressure – min. load – max. cooling	~~–7~~ 5	+55	+43	+25
6	**Rated voltage**	High back pressure – max. load – min. cooling	~~+12~~ 15	+65	+43	+25
7	**Rated voltage**	High back pressure – min. load – min. cooling	~~–7~~ 5	+55	+43	+25

During tests 4, 5, 6 and 7,

– *the temperature rises of ~~the compressor and the protective electronic control system~~ the* motor-compressor control system and the motor-compressor protection system containing electronic components *are measured and shall not exceed the values given in the Table 3 of Part 1, reduced by 7 K;*

– *the* ***motor-compressor protective electronic circuit*** *shall not operate to disconnect the* ***motor-compressor*** *from the supply;*

– *the temperature of the* ***housing*** *and the temperature of the accessible surfaces of associated components shall not exceed 150 °C.*

NOTE 1 Steady conditions are considered to be obtained when three successive readings of the temperature, taken at approximately 10 min intervals, at the same point of any operating cycle, do not differ by more than 1 K.

NOTE 2 The tolerances on the temperatures in Table AA.2 are ±2 K for the **motor-compressor** ambient temperature, condensation and return gas temperatures, and ±1 K for the evaporation temperature.

NOTE 3 For some **motor-compressors**, an injection cooler or an oil cooler and air flow over the **motor-compressor** may be required as recommended by the **motor-compressor** manufacturer.

NOTE 4 The evaporation and condensation temperatures relate to the corresponding saturated vapour pressures of the refrigerant in use, and are measured by means of the pressure gauges as "suction" and "discharge" respectively in Figure AA.1. For refrigerant blends, the saturated vapour pressure is taken as the pressure at the dew point temperature.

NOTE 5 The return gas temperature is measured by means of a thermocouple, situated in the suction line at point A as shown in Figure AA.1.

NOTE 6 The test is carried out at a 43 ºC ambient temperature so as to produce a maximum load on the **motor-compressor**. It is not intended that this be the reference ambient temperature for the temperature rises given in Table 3 of Part 1.

NOTE 7 The requirements in Table 3 regarding winding temperatures of the different insulation classes are not applicable to the windings of **motor-compressors**.

AA.5 *If during the test of Clause AA.4 that results in the highest temperature of the* ***housing****, a declared safety function reduces the* ***motor-compressor*** *speed, the tests of Clause AA.5 are performed at the reduced speed.*

The test of 4, 5, 6 or 7 in Table AA.2 that resulted in the highest temperature of the ***housing*** *is then repeated until steady conditions are reached.*

For refrigerants other than R-744, the condensing temperature is then increased in steps of 5 K until steady conditions are reached at each step. This procedure is continued until one of the following conditions occurs:

– ***the motor-compressor protective electronic circuit*** *operates to disconnect the* ***motor-compressor*** *from the supply;*

– *the* ***motor-compressor*** *stalls and steady conditions are reached.*

For R-744 refrigerant, the operating discharge pressure is then increased in steps of 0,8 MPa until steady conditions are reached at each step. This procedure is continued until one of the following conditions occurs:

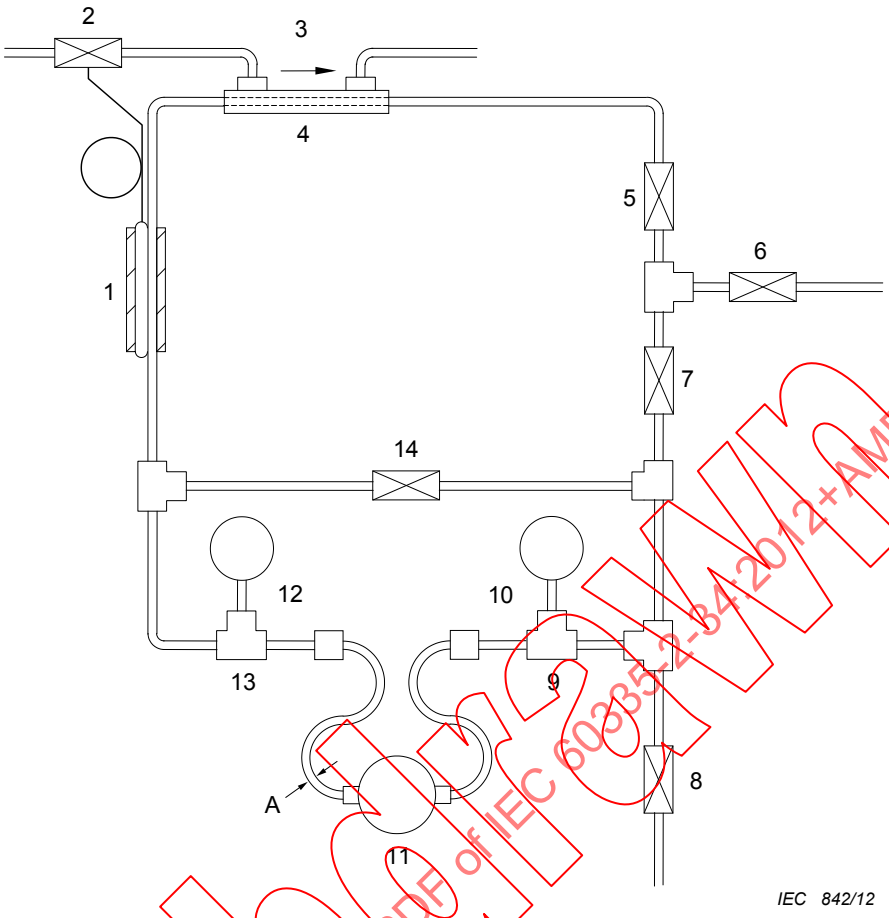
– *the* ***motor-compressor protective electronic circuit*** *operates to disconnect the* ***motor-compressor*** *from the supply;*

– *the* ***motor-compressor*** *stalls and steady conditions are reached*

In neither of these conditions shall the ***motor-compressor*** *winding temperature exceed 160 °C for* ***motor-compressors*** *with synthetic insulation and 150 °C for* ***motor-compressors*** *with cellulosic insulation.*

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

If the **motor-compressor** is of the single-phase type with an internally mounted **motor-compressor protective electronic circuit**, the combined resistance of the main winding and start winding, in series, is used. If the **motor-compressor** is of the three-phase type with an internally mounted **motor-compressor protective electronic circuit**, it will be necessary to first establish the trip point then re-run the test and measure the resistance after shut-down, just prior to the **motor-compressor protective electronic circuit** tripping. A continuous resistance recording technique may be used if the temperatures correlate properly with those obtained by the shut-down resistance method.



Key

1	Thermostat sensor	8	Reclaim valve
2	Thermostatically controlled water valve	9	Discharge pressure line
3	Cooling water	10	Discharge
4	Heat exchanger	11	Motor-compressor
5	Suction control	12	Suction
6	Charging valve	13	Suction line
7	Discharge pressure control	14	Pressure equalizing valve

NOTE 1 Point A is the return gas temperature measuring point – approximately 300 mm from the **housing**.

NOTE 2 The complete substitute cooling system can be located in the temperature controlled room (see Table AA.1) or, alternately, only the **motor-compressor** need be in this controlled ambient.

NOTE 3 Additional components, such as discharge line heaters or suction return gas heaters and coolers can be added as needed, as long as the specified temperatures and conditions of Table AA.1 are maintained. A replaceable filter dryer ~~may~~ can be added between the discharge pressure gauge and the discharge pressure control valve.

NOTE 4 For some **motor-compressors**, an additional means for reducing the motor temperature, such as an oil cooler and air flow over the **motor-compressor**, can be required as recommended by the **motor-compressor** manufacturer. The heat removal will be done in conformity with the **motor-compressor** manufacturer's recommendations.

NOTE 5 In case an oil separator is required by the **motor-compressor** manufacturer, it can be incorporated in the substitute cooling system, as recommended by the **motor-compressor** manufacturer.

Figure AA.1 – Substitute refrigeration circuit

Annex BB
(normative)

Winding wire insulation compatibility tests

NOTE CAUTION: Extreme care should be taken when conducting this test. There are elevated pressure levels within the test vessels which are also under elevated ambient conditions. In addition, mixing of some chemicals and/or lubricants followed by exposure to high temperatures could produce toxic fumes and/or materials.

BB.1 Testing of winding wire insulation shall be conducted on two sets of six representative samples as follows:

a) Film-coated winding wire shall be prepared in accordance with 4.4.1 of IEC 60851-5:2008 except that samples for the refrigerant and oil exposure shall not have the loop at the end removed until after the refrigerant and oil exposure.

b) Other winding wires shall be straight lengths of wire.

BB.2 The size of the test samples shall be the smallest nominal wire size (diameter) intended for use on the **motor-compressor.**

BB.3 One set of six samples shall be maintained in the as-received condition (no exposure to refrigerant and oil). Another set of six samples shall be prepared for the refrigerant and oil exposure testing.

BB.4 The six as-received samples of winding wire shall be subjected to the electric strength test of 16.3 except that the applied voltage shall be 125 % of the maximum **working voltage** of the **motor-compressor**, but not less than 500 V. The test voltage is applied between the conductors of the wires. The winding wire tested shall withstand the application of the test voltage specified without breakdown.

BB.5 The set of six samples prepared for the refrigerant and oil exposure testing shall be placed in test vessel(s) and each test vessel shall be provided with a pressure relief device. Each test vessel shall then be sealed, evacuated to 100 μm of mercury or less and heated to not less than 150 °C for at least 1 h.

NOTE A safety control other than a pressure relief device can be used if it serves the purpose of preventing excessive pressure build-up within a test vessel.

BB.6 The oil shall be added within each test vessel so that all samples will remain partially immersed in the refrigerant-oil-mixture throughout the duration of the test, including during the no heat period.

BB.7 Each test vessel shall then be re-sealed, evacuated and heated in accordance with Clause BB.5.

BB.8 Each test vessel shall then be charged with the refrigerant vapour in a manner which does not permit air to be introduced into the test vessel. The pressure of the refrigerant vapour shall be any convenient pressure between 1,0 MPa and 2,4 MPa for any refrigerant other than transcritical R-744, which shall be at a pressure of not less than 7,3 MPa.

BB.9 The test samples shall be tested as detailed in Table BB.1. The time of heating shall be divided into five equal heating periods. Each heating period is followed by a period without heating. The period without heating shall be at a temperature of approximately 25 °C for 48 h.

BB.10 The time temperature heating cycle used for the test is selected by the manufacturer.

Table BB.1 – Time temperature heating cycles

Heating temperature	Total heating time	Heating period
°C	h	h
140	1 440	288
145	1 080	216
150	720	144
155	540	108
160	360	72
175	240	48

BB.11 Immediately after being exposed to the refrigerant and oil, the winding wire samples shall be subjected to the electric strength test of 16.3 except that the applied voltage shall be not less than 100 % of the maximum **working voltage** of the **motor-compressor** for which the winding wire is intended to be used. The test voltage is applied between the conductors of the wires. The winding wire tested shall withstand the application of the test voltage specified without breakdown.

Annex CC
(normative)

Tie cords and insulation compatibility tests

NOTE 1 CAUTION: Extreme care should be taken when conducting this test. There are elevated pressure levels within the test vessels which are also under elevated ambient conditions. In addition, mixing of some chemicals and/or lubricants followed by exposure to high temperatures could produce toxic fumes and/or materials.

NOTE 2 Annex CC is not applicable to winding wire insulation.

CC.1 Testing of tie cords, insulating system materials or parts shall be conducted on two sets of six representative samples as follows:

a) Tie cords shall be at least 500 mm long and of the minimum nominal thickness intended for use on the **motor-compressor**.

b) Insulating system materials shall be of an amount approximately proportional to their use in the system. They shall be of the minimum nominal thickness intended for use on the **motor-compressor** and having an overall size so the test in Clause CC.3 can be conducted without flashover.

c) Parts such as an internal motor terminal assembly or lead connection block shall be the actual type and size as intended for use in the **motor-compressor**.

NOTE A suggested overall size for the other insulating system materials is approximately 50 mm × 50 mm.

CC.2 One set of six samples shall be maintained in the as-received condition (no exposure to refrigerant and oil). Another set of six samples shall be prepared for the refrigerant and oil exposure testing.

CC.3 The six as-received samples of insulating materials or parts shall be subjected to the electric strength test of 16.3 except that the applied voltage shall be not less than 125 % of the maximum **working voltage** of the circuit for which the materials are intended, but not less than 500 V.

CC.4 If the parts to be tested are:

a) insulating materials other than tubing or leads, the test electrodes shall be opposing cylindrical rods, sized 5 mm diameter with edges rounded to a 1 mm radius;

NOTE The electrode size can be varied from the size specified to accommodate testing of small parts.

b) tubing, the test electrodes shall be a copper conductor and spherical metal shot. The copper conductor shall be of a size approximately equal to the tubing internal diameter and then inserted into the tubing. The tubing and conductor shall be bent 180° over a mandrel having a diameter of not more than 10 mm. The metal shot shall be sized 2 mm to 3 mm diameter. The tubing and conductor shall be inserted into the metal shot such that the test voltage is applied between the conductor within the tubing and the metal shot;

c) leads, the tests electrodes shall be the wire within the lead and metal foil 50 mm long, wrapped around the lead and centred on the lead length. The test voltage shall be applied between the wire within the lead and the metal foil.

CC.5 The insulation or parts tested shall withstand the application of the test voltage specified without breakdown.

CC.6 The six as-received sample tie cords shall be subjected to a breaking test as follows:

a) Tie cord breaking strength shall be determined by using constant rate of specimen extension tensile testing machine. Clamping jaws, such as of the drum or capstan type to prevent slippage or breakage of the tie cord, shall be used. The distance between the contact points of the jaws shall be adjusted to 250 mm ±10 mm.

b) Tie cord samples shall be installed and aligned in the test machine jaws. The movable jaw shall be operated at a speed of 300 mm/min ±10 mm/min. If a sample breaks within 10 mm of the jaw contact point, the results shall be disregarded and another sample tested.

CC.7 The average tie cord breaking strength shall be recorded.

CC.8 The set of six samples prepared for the refrigerant and oil exposure testing shall be placed in test vessel(s) and each test vessel shall be provided with a pressure relief device. Each test vessel shall then be sealed, evacuated to 100 μm of mercury or less and heated to not less than 150 °C for at least 1 h.

NOTE A safety control other than a pressure relief device can be used if it serves the purpose of preventing excessive pressure build-up within a test vessel.

CC.9 The oil shall be added within each test vessel so that all samples will remain partially immersed in the refrigerant-oil-mixture throughout the duration of the test, including during the no heat period.

CC.10 Each test vessel shall then be re-sealed, evacuated and heated in accordance with Clause CC.8.

CC.11 Each test vessel shall then be charged with the refrigerant vapour in a manner which does not permit air to be introduced into the test vessel. The pressure of the refrigerant vapour shall be any convenient pressure between 1,0 MPa and 2,4 MPa for any refrigerant other than transcritical R-744, which shall be at a pressure of not less than 7,3 MPa.

CC.12 The test samples shall be tested as detailed in Table CC.1. The time of heating shall be divided into five equal heating periods. Each heating period is followed by a period without heating. The period without heating shall be at a temperature of approximately 25 °C for 48 h.

CC.13 The time temperature heating cycle used for the test is selected by the manufacturer.

Table CC.1 – Time temperature heating cycles

Heating temperature	Total heating time	Heating period
°C	h	h
140	1 440	288
145	1 080	216
150	720	144
155	540	108
160	360	72
175	240	48

CC.14 Immediately after being exposed to the refrigerant and oil:

a) Tie cord samples shall be subjected to the breaking strength test in accordance with Clause CC.6. Not less than five of the six tie cord samples exposed to refrigerant and oil shall have a breaking strength of at least 80 % of the average as-received tie cord breaking strength.

b) Other insulation samples shall be subjected to the strength test of 16.3 except that the applied voltage shall be not less than 100 % of the maximum **working voltage** of the circuit for which the materials are intended. The insulation or parts tested shall withstand the application of the test voltage specified without breakdown.

Annex DD
(normative)

Non-sparking “n” electrical apparatus

Where within this standard reference is made to IEC 60079-15, the following clauses are applicable.

16 General supplementary requirements for equipment producing arcs, sparks or hot surfaces

Clause 16 is applicable.

17 Supplementary requirements for enclosed-break devices and non-incendive components producing arcs, sparks or hot surfaces

Clause 17 is applicable.

18 Supplementary requirements for hermetically sealed devices producing arcs, sparks or hot surfaces

Clause 18 is applicable.

19 Supplementary requirements for sealed devices producing arcs, sparks or hot surfaces

Clause 19 is applicable.

20 Supplementary requirements for restricted-breathing enclosures protecting apparatus producing arcs, sparks or hot surfaces

Clause 20 is applicable.

Bibliography

The bibliography of Part 1 is applicable except as follows.

Addition:

IEC 60335-2-11, *Household and similar electrical appliances – Safety – Part 2-11: Particular requirements for tumble dryers*

IEC 60335-2-24, *Household and similar electrical appliances – Safety – Part 2-24: Particular requirements for refrigerating appliances, ice-cream appliances and ice-makers*

IEC 60335-2-40, *Household and similar electrical appliances – Safety – Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers*

IEC 60335-2-75, *Household and similar electrical appliances – Safety – Part 2-75: Particular requirements for commercial dispensing appliances and vending machines*

IEC 60335-2-89, *Household and similar electrical appliances – Safety – Part 2-89: Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant unit or compressor*

ISO 817, *Refrigerants – Designation system*

IEC 60335-2-34

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Household and similar electrical appliances – Safety – Part 2-34: Particular requirements for motor-compressors

IEC 60335-2-34:2012-05+AMD1:2015-05 CSV(en)

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-34: Particular requirements for motor-compressors

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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8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

This consolidated version of the official IEC Standard and its amendment has been prepared for user convenience.

IEC 60335-2-34 edition 5.1 contains the fifth edition (2012-05) [documents 61C/508/FDIS and 61C/517/RVD] and its amendment 1 (2015-05) [documents 61C/597/FDIS and 61C/603/RVD].

This Final version does not show where the technical content is modified by amendment 1. A separate Redline version with all changes highlighted is available in this publication.

This part of International Standard IEC 60335 has been prepared by subcommittee 61C: Safety of refrigeration appliances for household and commercial use, of IEC technical committee 61: Safety of household and similar electrical appliances.

The principal changes in this edition as compared with the fourth edition of IEC 60335-2-34 are as follows (minor changes are not listed):

– some notes have been deleted or converted to normative text (1, 6.103, 19.14, 22.7, Figure 101);
– manufacturer must declare the type of motor protection used (5.102, 6.104);
– tests to fault-test **motor-compressors** incorporating **electronic circuits** introduced (19.11.2, AA.5);
– application of the EMP tests clarified (19.11.4);
– testing of contactors and relays associated with **motor-compressors** introduced (19.14);
– tables 101 and 102 updated and corrected;
– running overload test conditions extended (AA.1, AA.2, AA.3, AA.4, AA.5).

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 motor-compressors.

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 smaller roman type.

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

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 the base publication and its amendment 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.

NOTE 4 The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations may need a transitional period following publication of a new, amended or revised IEC publication in which to make products in accordance with the new requirements and to equip themselves for conducting new or revised tests.

It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not earlier than 12 months or later than 36 months from the date of publication.

The following differences exist in the countries indicated below:

– 7.1: The locked-rotor current marking is required for some motor-compressors (USA).

– 22.7: Different test pressures are used (Japan, USA).

The contents of the corrigendum of June 2015 of Amendment 1 have been included in this copy.

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 and takes into account the way in which electromagnetic phenomena can affect the safe operation of appliances.

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

If 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.

If testing of the **motor-compressor** includes testing in accordance with Annex AA, temperatures of the **motor-compressor** windings, **housing** and other parts related to the **motor-compressor**, such as terminals, internal wiring and insulating materials, are not measured when the complete appliance in which the **motor-compressor** is used is tested.

These requirements apply to sealed (hermetic and semi-hermetic type) **motor-compressors** with their associated starting, cooling capacity control and protection systems, tested separately under the most severe conditions of the refrigerating system operation which, within reasonable limits, could occur in the applications for which they are used.

In particular, the construction detail inspection and locked-rotor testing may be done separately on the **motor-compressor,** thereby eliminating the need for inspection and testing when the **motor-compressor** is applied to many different appliances and factory-built assemblies.

Operational tests may also be conducted on the **motor-compressor** separately in certain circumstances. The specification for this type testing is provided in Annex AA. However, the tests of the existing standards relevant to the given kind of application, such as IEC 60335-2-24 and IEC 60335-2-40, may need to be conducted on the final application and used as the final determination of acceptability.

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-34: Particular requirements for motor-compressors

1 Scope

This clause of Part 1 is replaced by the following.

This International Standard deals with the safety of sealed (hermetic and semi-hermetic type) **motor-compressors**, their protection and control systems, if any, which are intended for use in equipment for household and similar purposes and which conform with the standards applicable to such equipment. It applies to **motor-compressors** tested separately, under the most severe conditions that may be expected to occur in normal use, their **rated voltage** being not more than 250 V for single-phase **motor-compressors** and 480 V for other **motor-compressors**.

This standard also covers

– multi-speed **motor-compressors**, that are **motor-compressors**, the speed of which can be set to different values;

– variable capacity **motor-compressors**, that are **motor-compressors** where the capacity of the compressor is controlled at fixed speeds.

NOTE 101 Examples of equipment which contain **motor-compressors** are

– refrigerators, food freezers and ice makers (IEC 60335-2-24);

– air-conditioners, electric heat pumps and dehumidifiers (IEC 60335-2-40);

– commercial dispensing appliances and vending machines (IEC 60335-2-75);

– factory-built assemblies for transferring heat in applications for refrigerating, air-conditioning or heating purposes or a combination of such purposes.

This standard does not supersede the requirements of standards relevant to the particular appliance in which the **motor-compressor** is used. However, if the **motor-compressor** type used complies with this standard, the tests for the **motor-compressor** specified in the particular appliance standard may not need to be made in the particular appliance or assembly. If the **motor-compressor control system** is associated with the particular appliance control system, additional tests may be necessary on the final appliance.

So far as is practical, this standard deals with the common hazards presented by **motor-compressors** used in appliances which are encountered by all persons in and around the home. However, it does not in general take into account

– the use of appliances by young children or infirm persons without supervision;

– playing with the appliances by young children.

NOTE 102 Attention is drawn to the fact that

– for **motor-compressors** intended to be used in appliances in vehicles or on board ships, additional requirements may be necessary;

– in many countries, additional requirements are specified by the national health authorities, the national authorities responsible for the protection of labour and similar authorities.

NOTE 103 This standard does not apply to

– **motor-compressors** designed exclusively for industrial purposes;

– motor-compressors used in 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).

NOTE 104 If **motor-compressors** for refrigerant R-744 used in appliances with a **transcritical refrigeration system** are equipped with **pressure relief devices**, compliance with the requirements for these devices is checked during the tests on the final appliance.

2 Normative references

This clause of Part 1 is applicable, except as follows.

Addition:

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

IEC 60851-4, *Methods of test for winding wires – Part 4: Chemical properties*

IEC 60851-5:2008, *Winding wires – Test methods – Part 5: Electrical properties*

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

3 Terms and definitions

This clause of Part 1 is applicable, except as follows.

3.101
motor-compressor
appliance consisting of the mechanical mechanism of the compressor and the motor, both of which are enclosed in the same sealed **housing**, with no external shaft seals, and with the motor operating in a refrigerant atmosphere with or without oil

Note 1 to entry: The **housing** may be permanently sealed, such as by welding or brazing (**hermetic motor-compressor**), or may be sealed by gasketted joints (**semi-hermetic motor-compressor**). A terminal box, a terminal box cover, and other electrical components or an electronic control system may be included.

Note 2 to entry: Hereafter, the term **motor-compressor** will be used to designate either a **hermetic motor-compressor** or **semi-hermetic motor-compressor**.

3.102
housing
sealed enclosure for the **motor-compressor**, which contains the compressor mechanism and the motor, and which is subjected to refrigerant pressures

3.103
thermal motor-protector
automatic control, built-in or fitted on a **motor-compressor**, that is specifically intended to protect the **motor-compressor** against over-heating due to running overload and failure to start

Note 1 to entry: This control carries **motor-compressor** current and is sensitive to one or both of the following:

– **motor-compressor** temperature;

– **motor-compressor** current.

Note 2 to entry: The control is capable of being reset (either manually or automatically) when its temperature falls to the reset value.

3.104
motor-compressor protection system
thermal motor protector and associated components, if any, or **protective electronic circuit** fully or partly separate or integrated into the **motor-compressor control system** and which is specifically intended to protect the **motor-compressor** against over-heating due to running overload or failure to start

Note 1 to entry: The control carries **motor-compressor** current and is sensitive to one or both of the following:

– **motor-compressor** temperature;

– **motor-compressor** current.

3.105
motor-compressor control system
system comprising one or more electrical or **electronic components,** or **electronic circuits** that provides at least one of the following:

– **motor-compressor** starting control functions;

– **motor-compressor** cooling capacity control functions

3.106
starting relay
electrically operated control device intended for integration or incorporation into a **motor-compressor** and used within the **motor-compressor** circuit to control the starting of single-phase **motor-compressors**

3.107
application category
back pressure relative to the evaporation temperature range over which the **motor-compressor** operates

Note 1 to entry: For the purpose of this standard, the following classifications of application categories are made relative to the evaporation temperature range:

– low back pressure (LBP): denotes an evaporation temperature range from –35 °C to –15 °C;

– medium back pressure (MBP): denotes an evaporation temperature range from –20 °C to 0 °C;

– high back pressure (HBP): denotes an evaporation temperature range from –5 °C to +15 °C.

3.108
transcritical refrigeration system
refrigeration system where the pressure in the high pressure side is above the pressure where the vapour and liquid states of the refrigerant can coexist in thermodynamic equilibrium

3.109
design pressure
gauge pressure that has been assigned to a **transcritical refrigeration system**

Note 1 to entry: It is specified for the high pressure side of a refrigeration system.

3.110
pressure relief device
pressure sensing device, intended to reduce pressure automatically when pressures within the refrigeration system exceed the preset pressure of the device

Note 1 to entry: This device has no provisions for setting by the end user.

3.111
two-stage motor-compressor
motor-compressor comprising two compressors and one motor in a single **housing**

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:*

At least one additional sample is required for the tests of clause 19, however further samples may also be provided or are needed.

For the test of 22.7, two samples of the ***housing*** *are required.*

5.7 *Replacement:*

Tests are carried out in an ambient temperature of 20 °C ± 5 °C.

5.8.2 *Addition:*

Motor-compressors *with* ***self-resetting motor-compressor protection systems,*** *and designed for more than one* ***rated voltage,*** *are subjected to the tests of 19.101 and 19.103 at the highest voltage.*

5.10 *Addition:*

For the tests of Clause 19, the additional sample or samples shall be identical in all respects to the test sample, charged with oil, if necessary, and vapour refrigerant. The sample has to be provided with the ***motor-compressor protection system****,* ***starting relay****, start capacitor, run capacitor and control system, if any, as specified by the manufacturer, except that the rotor shall have been locked by the manufacturer.*

The manufacturer or responsible agent shall provide the following information for each type of ***motor-compressor*** *submitted for the tests:*

– *type (synthetic or cellulosic) of winding insulation;*
– *refrigerant identification:*
  a) *for a single component refrigerant, by at least one of the following:*
    - *chemical name;*
    - *chemical formula;*
    - *refrigerant number;*
  b) *for a blended refrigerant, at least one of the following:*
    - *chemical name and nominal proportion of each of the components;*
    - *chemical formula and nominal proportion of each of the components;*
    - *refrigerant number and nominal proportion of each of the components;*
    - *refrigerant number of the refrigerant blend;*
– *types and quantity of oil to be used if the test samples which use oil are not already charged;*
– ***application category*** *or* ***application categories*** *for* ***motor-compressors*** *classified as being tested with Annex AA;*
– *whether a* ***supply cord*** *can be connected directly to terminals on the* ***motor-compressor****;*

– *for **motor-compressors** intended for appliances with a **transcritical refrigeration system**, the test pressure for the high pressure side if higher than the minimum test pressure.*

5.11 *Replacement:*

*For **motor-compressors** which can be used in appliances where the **supply cord** is connected directly to terminals on the **motor-compressor**, the test sample shall be provided with a **supply cord**.*

NOTE 101 Any additional samples required for testing need not be provided with a **supply cord**.

5.101 ***Motor-compressors**, including those with crank-case heaters, are tested as **motor-operated appliances**.*

5.102 *With regard to 6.104, **protective devices** other than the declared device under test shall be disabled during the tests of Annex AA and Clause 19. If multiple **protective devices** are declared, each shall be tested independently.*

5.103 *For cascade systems comprising two or more motor-compressor circuits, each **motor-compressor** circuit is tested separately in the end product. IEC 60335-2-34 is not applicable for the system but each **motor-compressor** can be tested according to this standard.*

6 Classification

This clause of Part 1 is applicable, except as follows.

6.101 Motor-compressors not incorporating an **electronic circuit** are classified as being tested with Annex AA or without Annex AA.

Motor-compressors incorporating an **electronic circuit** are classified as being tested with Annex AA.

Motor-compressors can be classified as being tested with Annex AA only if the **motor-compressor** in combination with the **motor-compressor protection system** or **motor-compressor control system**, if any, can be configured to operate so as to deliver maximum cooling capacity, independently of any input sensors that are only provided as part of the final application.

NOTE **Motor-compressors** classified as being tested without Annex AA and their protection system or control system, if any, are normally subjected to a heating test as a complete system in the final application in accordance with the appropriate appliance standard.

Compliance is checked by

– *the tests of this standard including the tests in Annex AA, for **motor-compressors** tested with Annex AA;*

– *the tests of this standard but not including the tests in Annex AA, for **motor-compressors** tested without Annex AA.*

6.102 Motor compressors are classified as being

– intended for direct connection of the appliance **supply cord** to the **motor-compressor** terminals, or

– not intended for direct connection of the appliance **supply cord** to the **motor-compressor** terminals.

NOTE 1 **Motor-compressors** can in both cases be delivered with or without the external components necessary for connection of the **supply cord**.

NOTE 2 **Motor-compressors** intended for direct connection of the appliance **supply cord** to their terminals can also be used without the **supply cord** being connected directly to their terminals.

NOTE 3 If the **motor-compressor** is used without the relevant components or with components different from those specified by the manufacturer, additional testing in accordance with the appropriate appliance standard can be necessary.

Compliance is checked by inspection and by the relevant tests.

6.103 Motor-compressors are classified as being protected by **protective electronic circuits** or not being protected by **protective electronic circuits**.

This does not preclude the **protective electronic circuits** being provided in the end product, in which case many of the tests of this standard shall be conducted on the end product.

Compliance is checked by inspection and by the relevant tests.

6.104 *The **motor-compressor** manufacturer shall declare the means of motor protection, **thermal motor protector**, impedance protection, **protective electronic circuit**, or a combination of the above.*

Compliance is checked by inspection and by the relevant tests.

6.105 Motor-compressors using refrigerant R744 shall be classified as used in a **transcritical refrigeration system** or in a non-**transcritical refrigeration system**.

Compliance is checked by inspection and by the relevant tests.

7 Marking and instructions

This clause of Part 1 is applicable, except as follows.

7.1 *Modification:*

The **rated power input** or **rated current** need not be marked.

Addition:

Motor-compressors suitable for use with a flammable refrigerant shall be marked with symbol ISO 7010 W021.

7.5 Not applicable.

7.6 *Addition:*

Symbol ISO 7010 W021 Warning; flammable materials

7.7 Not applicable.

7.12 Not applicable, except 7.12.1 which is applicable.

7.13 Not applicable.

7.101 Refrigerants that can be used with the **motor-compressor** shall be listed in the instructions.

Compliance is checked by inspection.

8 Protection against access to live parts

This clause of Part 1 is applicable.

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 not applicable.

11 Heating

This clause of Part 1 is not applicable.

NOTE 101 For **motor-compressors**, this clause of Part 1 can be covered by Annex AA.

12 Void

13 Leakage current and electric strength at operating temperature

This clause of Part 1 is not applicable, except 13.3 as required by 19.104.

14 Transient overvoltages

This clause of Part 1 is applicable.

15 Moisture resistance

This clause of Part 1 is applicable, except as follows.

15.3 *Addition:*

NOTE 101 **Motor-compressors** with glass-insulated terminals and without any external control devices, protectors or other components need not be tested.

16 Leakage current and electric strength

This clause of Part 1 is applicable.

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:*

Replace the test specification by the following:

Motor-compressors *are submitted to the tests of 19.14, 19.15, 19.101, 19.102, 19.103 and, additionally, if so required by the classification of 6.101, to the tests specified in Annex AA.*

Motor-compressors *incorporating* ***electronic circuits*** *are also subjected to the tests of 19.11 and 19.12.*

Only one abnormal condition is simulated each time.

Compliance with the tests of 19.11 and 19.12 is checked as described in 19.13. Compliance with the tests of 19.101, 19.102 and 19.103 is checked as described in 19.104. Compliance with the tests of Annex AA is checked as described in Annex AA.

19.2 to **19.10** Not applicable.

19.11.2 *Addition:*

For simulation of the fault conditions, a ***motor-compressor*** *incorporating an* ***electronic circuit*** *is connected to the substitute refrigeration circuit of Figure AA.1 and operated under the conditions given in Clause AA.5. The condensing temperature applied being 5 K lower than that which caused the* ***motor-compressor protective electronic circuit*** *to operate or the* ***motor-compressor*** *to stall during the test of Clause AA.5.*

19.11.3 *Replacement:*

If the ***motor-compressor*** *is classified as being protected by a* ***protective electronic circuit*** *and if this* ***protective electronic circuit*** *operates to ensure compliance with Clause 19 and Annex AA, the tests of 19.101, 19.102, 19.103 and Annex AA are repeated with a single fault simulated, as indicated in a) to g) of 19.11.2.*

However, the test of Annex AA is not repeated if during the test of Annex AA, for ***motor-compressors*** *classified as being tested with Annex AA, the* ***motor-compressor protection system*** *did not operate. The test of Annex AA is also not repeated on* ***motor-compressors*** *that are classified as being tested without Annex AA.*

19.11.4 *Addition:*

If the tests have to be carried out, they shall be carried out in the end product application.

NOTE 101 The application of these tests in this part 2 is not mandatory since they are conducted in the end product application.

19.13 *Addition:*

If the ***motor-compressor*** *is intended to use flammable refrigerants, and if during the tests of 19.11.2 and 19.11.3 any electrical component produced sparks or arcs, this shall be reported*

*unless the component was an **intentionally weak part** or a **non-self-resetting protective device**.*

19.14 *Replacement:*

***Motor-compressors** are operated under the conditions of Clause AA.1. Any contactor or relay contact that operates under the conditions of Clause AA.1 is short-circuited.*

If a relay or contactor with more than one contact is used, all contacts are short-circuited at the same time.

*Any relay or contactor which operates only in order to ensure that the **motor-compressor** is energized for normal use and that does not otherwise operate in normal use is not short-circuited.*

If more than one relay or contactor operates in Clause AA.1, each such relay or contactor is short-circuited in turn.

*For **motor-compressors** that use alternate start capacitors, the test shall be carried out using each alternate start capacitor in turn.*

*The test is only performed on **motor-compressors** classified as being tested with Annex AA.*

NOTE 1 For **motor-compressors** not classified as being tested with Annex AA, this test will be performed on the final product.

NOTE 2 If the **motor-compressor** has several modes of operation, the tests are carried out with the **motor-compressor** operating in each mode, if necessary.

19.101 *The **motor-compressor** and **motor-compressor protection system**, together with all their associated components which operate under locked-rotor conditions, are connected in the circuit shown in Figure 101 and supplied with **rated voltage** as specified in 5.8.2.*

NOTE 1 The associated components which comply with the requirements in Clause 24 are not evaluated by this test.

*For **motor-compressors** with a **non-self-resetting thermal motor-compressor protection system**, the **motor-compressor** is operated until a sufficient number of operations have been made to ensure that continuous automatic recycling does not occur. The number of operations should, however, not be less than three and should be performed as rapidly as possible with a minimum delay of 6 s.*

*A longer off time is permitted if a delay feature longer than 6 s is part of the **protection system** or **control system**.*

*All electromechnical components of the **protection system** shall be tested individually for 50 operations in total with the **motor-compressor** or with a load corresponding to the actual **motor-compressor** or a higher load.*

*For **motor-compressors** with a **self-resetting motor-compressor protection system**, the **motor-compressor protection system** is allowed to cycle continuously for a period of 15 days or for at least 2 000 cycles, whichever is the longer.*

***Motor-compressors** without a **motor-compressor protection system** and only protected by the impedance of the windings, are connected in the circuit shown in Figure 101 and supplied with rated voltage. If a **motor-compressor** is designed for more than one rated voltage it is tested at the highest voltage.*

*At the conclusion of the first 72 h of the locked-rotor test, the **motor-compressor** is subjected to the electric strength test as specified in 16.3.*

*For **motor-compressors** with a **self-resetting motor-compressor protection system,** if 2 000 cycles of the protection system have not been performed by the end of the 15-day period, the test may be terminated provided the following conditions are met:*

– *the **housing** temperature is recorded on the 12th and 15th days. If, during this three day period, the temperature has not increased by more than 5 K, the test can be terminated. If the temperature has increased by more than 5 K, the test is to be continued until the temperature has not increased by more than 5 K over a period of three consecutive days or for at least 2 000 cycles of the **motor-compressor protection system**, whichever occurs first;*

– *the components in the circuit comply with the requirements of clause 24 using at least the current and a power factor not exceeding that measured during the test.*

NOTE 2 If a given **motor-compressor**, **self-resetting motor-compressor protection system combination** is intended for use with more than one refrigerant, only one 15 day test is required, the choice of the refrigerant being made by the **motor-compressor** manufacturer.

NOTE 3 These test procedures can be modified, if necessary, to evaluate **motor-compressor protection systems** which incorporate special or unique features.

***Motor-compressors** with a **self-resetting motor-compressor protection system** and designed for more than one **rated voltage** are also tested at the lowest voltage for 3 h.*

NOTE 4 A separate sample can be used for the test at the lowest voltage.

*For **motor-compressors** where the design of the **protection system** or **control system** is such that the windings are de-energized permanently, the **motor-compressor** and **motor-compressor protection system** (if any), together with all their associated components which operate under locked-rotor conditions, are re-energized. This procedure is repeated as rapidly as possible until 10 operations have been performed, with a minimum off time of 6 s. A longer off time is permitted if a delay feature longer than 6 s is part of the **protection system** or **control system**.*

*If the **motor-compressor** is designed for more than one rated voltage, the test is performed at all rated voltages.*

*If the **motor-compressor** is designed for a voltage range, the test is performed at the upper and lower voltage limit.*

***Motor-compressors** without a **motor-compressor protection system** are left energized as described above for 15 days. The **housing** temperature is recorded on the 12th and 15th days. If during these three days, the temperature has not increased by more than 5 K, the test can be terminated.*

19.102 *The test of 19.101 is repeated for one operation of a **non-self-resetting motor-compressor protection system** or 3 h minimum for **self-resetting motor-compressor protection system** under the following conditions:*

– *with start and run capacitors open-circuited one at a time;*

– *with start and run capacitors short-circuited one at a time, unless they have been tested and shown to comply with the requirements for protection class P2 capacitors of IEC 60252-1.*

NOTE 1 The test with the capacitors open-circuited need not be conducted for **motor-compressors** where the open-circuited capacitors remove the start winding from the circuits.

NOTE 2 For **motor-compressors** with a **self-resetting motor-compressor protection system** and which are designed for more than one **rated voltage**, it is not necessary to repeat the test at the lowest voltage.

NOTE 3 This test can be performed on separate samples.

19.103 *Three-phase **motor-compressors** and the **motor-compressor protection systems**, together with all their associated components which operate under locked-rotor conditions, are connected in a circuit similar to that shown in Figure 101, the circuit being appropriately modified for three-phase **motor-compressors**. They are supplied with **rated voltage** but with one phase to the **motor-compressor** disconnected during the following periods:*

– *for **motor-compressors** with a **self-resetting motor-compressor protection system**, for 3 h;*

– *for **motor-compressors** with a **non-self-resetting motor-compressor protection system**, until the first operation of the **motor-compressor protection system**.*

– *for **motor-compressors** without a **motor-compressor protection system** for 3 h.*

NOTE This test can be carried out on a separate sample.

19.104 *During the tests of 19.101, 19.102 and 19.103,*

– *the **motor-compressor protection system** shall be able to operate;*

– *the temperature of the **housing** and the temperature of the accessible surfaces of associated components shall not exceed 150 °C;*

– *the residual current device shown in Figure 101 shall not operate;*

– *the **motor-compressor**, its associated **starting relay** and **motor-compressor protection system** shall not emit flames, sparks or molten metal.*

At the conclusion of the tests of 19.101, 19.103 and the test of 19.102 that is carried out with start and run capacitors open-circuited,

– *enclosures shall not have deformed to such an extent as to impair compliance with clause 29;*

– *the **motor-compressor protection system** shall be able to operate;*

– *the **motor-compressor** shall withstand*

- *the leakage current test as specified in 16.2, the test voltage being applied between the windings and the **housing**;*
- *the electric strength test of 13.3 of Part 1.*

If the test of 19.102 is carried out with start and run capacitors short-circuited one at a time, then at the conclusion of this test,

– *enclosures shall not have deformed to such an extent as to impair compliance with Clause 29;*

– *the **motor-compressor** shall withstand*

- *the leakage current test as specified in 16.2, the test voltage being applied between the windings and the **housing**;*
- *the electric strength test of 13.3 of Part 1;*

– *the **motor-compressor protection system** shall be able to operate or it shall remain permanently open-circuited.*

*If the **motor-compressor protection system** remains permanently open-circuited, the test of 19.102 with start and run capacitors short-circuited shall be repeated on three additional samples and all three additional samples shall remain permanently open-circuited at the conclusion of the test.*

NOTE The test can be repeated on three new **motor-compressors** or by replacing, in the **motor-compressor** originally tested, the **motor-compressor protection system** with one of the same type.

19.105 Three-phase **motor-compressors** shall be adequately protected against primary single-phase failure.

NOTE 1 Primary single-phase failure means that one of the three incoming lines to the primary of the transformer supplying the **motor-compressor** is disconnected.

Compliance is checked by the following test.

*The **motor-compressor** is supplied from a star-delta or delta-star connected transformer with a line voltage ratio such that the output voltage is equal to the **rated voltage** of the **motor-compressor**. The transformer is supplied with an input voltage such that the output voltage is equal to the **rated voltage** of the **motor-compressor**. One phase of the supply to the input windings of the transformer is then disconnected so that maximum current flows in an unprotected winding of the **motor-compressor**.*

The test is continued for the following periods:

– *24 h, for **motor-compressors** with a **self-resetting motor-compressor protection system**;*
– *until the first operation of the protective system, for **motor-compressors** with a **non-self-resetting motor-compressor protection system**.*

***Motor-compressors** designed for more than one **rated voltage** are tested at each voltage.*

*However, **motor-compressors** with a **self-resetting motor-compressor protection system** and designed for more than one **rated voltage** are tested at the highest voltage for 24 h and at the lowest voltage for 3 h.*

NOTE 2 Separate samples can be used in testing **motor-compressors** designed for more than one **rated voltage**, at each of their **rated voltages**.

During the test,

– *the temperature of the **housing** and the temperature of the accessible surfaces of associated components shall not exceed 150 °C;*
– *the **motor-compressor** windings shall not be damaged;*
– *the **motor-compressor** and **motor-compressor protection system** shall not emit flames, sparks or molten metal.*

NOTE 3 **Motor-compressor** windings are considered damaged if the windings open circuit or if the **motor-compressor** does not comply with the electric strength tests specifications. **Motor-compressors** with a **self-resetting motor-compressor protection system** are also considered damaged if there is a change in the relative distribution of currents during the test, or if currents measured at the conclusion of the test vary by more than 5 % from currents measured 3 h after the start of the test or on the first closure of the protective system following these 3 h.

*Immediately following this test, the **motor-compressor** shall withstand the electric strength test of 16.3.*

*A three-phase **motor-compressor** is considered to meet the requirement for primary single-phase failure protection without tests other than those specified in 19.101, 19.102 and 19.103, if it is protected by one of the following devices:*

– *an overcurrent device, protecting each phase of its supply and which is provided with the **motor-compressor** or the rating of which is specified by the **motor-compressor** manufacturer;*
– *a **motor-compressor protection system**, responsive to motor current, installed symmetrically at the centre point of a star-connected **motor-compressor** and which simultaneously opens at least two windings;*
– *a **motor-compressor protection system**, located in each winding of the **motor-compressor**, which activates pilot duty contacts controlling the supply to the coil of*

*the **motor-compressor** supply contactor and which is responsive to at least one of the following:*

- ***motor-compressor** current,*
- ***motor-compressor** temperature.*

20 Stability and mechanical hazards

This clause of Part 1 is applicable.

21 Mechanical strength

This clause of Part 1 is applicable.

22 Construction

This clause of Part 1 is applicable, except as follows.

22.2 Not applicable.

22.5 Not applicable.

22.7 *Replacement:*

Housings shall withstand the pressure expected in normal use.

Compliance is checked by the following tests.

*A **housing** which is exposed to high side pressure shall be subjected to a pressure equal to:*

– *for non **transcritical refrigeration systems**, a minimum of 3,5 times the saturated vapour pressure of the refrigerant at 70 °C, rounded up to the next 0,5 MPa (5 bar).*
– *for R-744 non-**transcritical refrigeration systems**, a minimum of 3,5 times the saturated vapour pressure of the refrigerant at 27 °C, rounded up to the next 0,5 MPa (5 bar).*

NOTE 101 Example of test pressure calculation for R-22 (subcritical):

Saturated vapour pressure at 70 °C (gauge with respect to atmospheric pressure at STP) = 2,89 MPa (28,9 bar)

Test pressure = 3,5 × 2,89 MPa (28,9 bar)

= 10,1 MPa (101 bar)

= 10,5 MPa (105 bar) when rounded up to the next 0,5 MPa (5 bar).

– *for **transcritical refrigeration systems**, 3 times the **design pressure** but not less than the minimum test pressure as required in Table 101.*
– *if the **motor-compressor** employs a bypass valve, a minimum of 3 times the maximum high side pressure, but not less than the minimum test pressure as required in Table 101.*

The test values for some refrigerants are given in Table 101. The values may, however, not be high enough for some applications.

Table 101 – Minimum high side test pressures

Refrigerant formulae	Refrigerant number	Test pressure MPa	(bar)
Non-transcritical			
CCl_2F_2	R-12	6,0	(60)
CF_3CH_2F	R-134a	6,5	(65)
$CHClF_2$	R-22	10,5	(105)
$CH(CH_3)_3$	R-600a	3,5	(35)
by weight 73,8 % R-12 + 26,2 % R-152a	R-500	10,0	(100)
by weight 48,8 % R-22 + 51,2 % R-115	R-502	10,5	(105)
by weight 44 % R-125 + 52 % R-143a + 4 % R-134a	R-404A	10,0	(100)
by weight 50 % R-125 + 50 % R-143a	R-507A	11,0	(110)
by weight 25 % R-125 + 52 % R-134a + 23 % R-32	R-407C	10,5	(105)
by weight 50 % R-125 + 50 % R-32	R-410A	15,0	(150)
Transcritical			
CO_2	R-744	42	(420)
Non-transcritical			
CO_2	R-744	23,0	(230)

*A **housing** which is exposed only to low side pressure shall, for both subcritical and transcritical applications, be subjected to a pressure equal to five times the saturated vapour pressure of the refrigerant at 20 °C or equal to 2,5 MPa (25 bar) whichever is higher, rounded up to the next 0,2 MPa (2 bar).*

*A **housing** which is exposed only to low side pressure in R-744 non-**transcritical refrigeration systems** shall be subjected to a pressure equal to a minimum of 5 times the saturated vapor pressure of the refrigerant at − 6,5 °C or equal to 13,5 MPa (135 bar), whichever is higher, rounded up to the next 0,2 MPa (2 bar).*

*A **housing** which is exposed only to low side pressure in **transcritical refrigeration systems** shall be subjected to a pressure equal to a minimum of 5 times the **design pressure** but not less than the minimum test pressure as required by Table 102.*

*For a **motor-compressor** employing a bypass valve, the **housing** which is exposed only to low side pressure shall be subjected to a pressure equal to 3 times the maximum low side pressure, but not less than the minimum test pressure as required in Table 102.*

The test values for some refrigerants are given in Table 102. The values may, however, not be high enough for some applications.

NOTE 102 Example of test pressure calculation for R-22 (subcritical):

Saturated vapour pressure at 20 °C (gauge with respect to atmospheric pressure at STP) = 0,81 MPa (8,1 bar)

Test pressure = 5 × 0,81 MPa (8,1 bar)

= 4,05 MPa (40,5 bar)

= 4,2 MPa (42 bar) when rounded up to the next 0,2 MPa (2 bar).

Table 102 – Minimum low side test pressures

Refrigerant formulae	Refrigerant number	Test pressure MPa	(bar)
Non-transcritical			
CCl_2F_2	R-12	2,5	(25)
CF_3CH_2F	R-134a	2,5	(25)
$CHClF_2$	R-22	4,2	(42)
$CH(CH_3)_3$	R-600a	2,5	(25)
by weight 73,8 % R-12 + 26,2 % R-152a	R-500	2,9	(29)
by weight 48,8 % R-22 + 51,2 % R-115	R-502	4,5	(45)
by weight 44 % R-125 + 52 % R-143a + 4 % R-134a	R-404A	5,0	(50)
by weight 50 % R-125 + 50 % R-143a	R-507A	5,5	(55)
by weight 25 % R-125 + 52 % R-134a + 23 % R-32	R-407C	4,0	(40)
by weight 50 % R-125 + 50 % R-32	R-410A	7,0	(70)
Transcritical			
CO_2	R-744	28,6	(286)
Non-transcritical			
CO_2	R-744	14,0	(140)

NOTE 103 Further information relating to refrigerant number designations can be obtained from ISO 817.

For refrigerant blends, the saturated vapour pressure is taken as the pressure at the dew point temperature.

*For two stage **motor-compressors** with direct discharge from the second stage, the **housing** is considered to be exposed to low side pressure.*

*For two stage **motor-compressors** without direct discharge from the second stage, the **housing** is considered to be exposed to high side pressure.*

The test shall be carried out on two samples. 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. This pressure is maintained for 1 min during which time the sample shall not leak except as indicated below.

*Where gaskets are employed for sealing the **housing** of a **semi-hermetic motor-compressor**, leakage at gaskets is not considered as a failure, provided the leakage occurs at a pressure greater than 40 % of the required test pressure.*

If a leakage occurs, the test has to be repeated on a sample specially prepared by the manufacturer to avoid leakage at the gasket.

*For a **semi-hermetic motor-compressor** employing a bypass valve which relieves high side pressure into the low side at a predetermined pressure differential, the **housing** shall be capable of withstanding the required test pressure even though leakage occurs at gaskets.*

NOTE 104 All pressures are gauge pressures.

22.9 *Addition:*

Insulating materials used within the **housing** shall be compatible with the refrigerant and oil used.

*For the types of refrigerant and types of oil for which the **motor-compressor** is intended to be used, compliance of winding wire insulation shall be checked by the tests detailed in Annex BB or **motor-compressors** that do not use oil by test 16 in IEC 60851-4 for resistance to refrigerants.*

For test 16 in IEC 60851-4, the percentage of extractable matter shall not exceed 0,5 %. The breakdown voltage shall be at least 75 % of the minimum specified value.

*For the types of refrigerant and types of oil for which the **motor-compressor** is intended to be used, compliance of tie cords and insulation materials other than winding wire insulation shall be checked by the tests detailed in Annex CC.*

22.14 Not applicable.

22.21 *Addition:*

NOTE 101 The requirement is applicable only to external parts of the **motor-compressor**.

22.101 Where a **motor-compressor** used in a **transcritical refrigeration system** includes a **pressure relief device** in the high side or discharge piping of the **motor-compressor**, there shall be no other shut off devices or system components except piping located between the **motor-compressor** and **pressure relief device** which could introduce a pressure drop.

NOTE The required **pressure relief device** could be installed by either the **motor-compressor** manufacturer or the appliance manufacturer.

Compliance is checked by inspection.

23 Internal wiring

This clause of Part 1 is applicable, except as follows.

23.8 *Addition:*

NOTE 101 This does not apply to wiring inside the **housing**.

24 Components

This clause of Part 1 is applicable, except as follows.

24.1.4 *Addition:*

– ***starting relay***	*100 000*
– ***self-resetting thermal motor-protectors** for **motor-compressors**** *	*2 000*
– ***non-self resetting thermal motor-protectors** for **motor-compressors***	*50*

* 2 000 or the number of operations during the 15 day locked-rotor test of 19.101, whichever is the greater.

24.101 In **motor-compressors** that employ flammable refrigerants, components that may arc or spark during **normal operation** of the end product shall comply with the requirements

of IEC 60079-15, as modified by Annex DD, for group IIA gases or the refrigerant used. This requirement is not applicable to components within the **housing**.

Compliance is checked by inspection and the appropriate tests of IEC 60079-15.

25 Supply connection and external flexible cords

This clause of Part 1 is applicable, except as follows, only if so required by the classification of 6.102.

25.1 *Addition:*

– a set of terminals allowing the connection of a **supply cord**.

25.7 Not applicable.

26 Terminals for external conductors

This clause of Part 1 is applicable only if so required by the classification of 6.102.

27 Provision for earthing

This clause of Part 1 is applicable, except as follows.

27.1 *Addition:*

An earthing terminal is required only if the **motor-compressor** is classified in accordance with 6.102 as being intended for direct connection of the appliance **supply cord** to the **motor-compressor** terminals.

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.

29.1 *Addition:*

Except as specified in 29.1.1 and 29.1.4, **clearances** less than those specified in Table 16 are not allowed for **basic insulation** and **functional insulation** inside the **housing**.

29.1.1 *Addition:*

Clearances inside the **housing** shall not be less than 1,0 mm for a rated impulse voltage of 1 500 V.

29.1.4 *Addition:*

Clearances inside the **housing** are reduced by 0,5 mm for rated impulse voltages of 2 500 V or more. Between winding wires and winding leads for motors or **thermal motor protectors**, no minimum **clearance** is specified.

29.2 *Addition:*

Pollution degree 1 applies inside the **housing**.

29.2.1 *Modification:*

Add the following to Note 2 in Table 17:

This does not apply to glass insulated terminals where corrosion protection extends over the glass.

29.2.4 *Modification:*

Add the following to Note 2 in Table 18:

This does not apply to glass insulated terminals where corrosion protection extends over the glass.

30 Resistance to heat and fire

This clause of Part 1 is applicable only to non-metallic and insulating materials which are outside the **housing** except as follows.

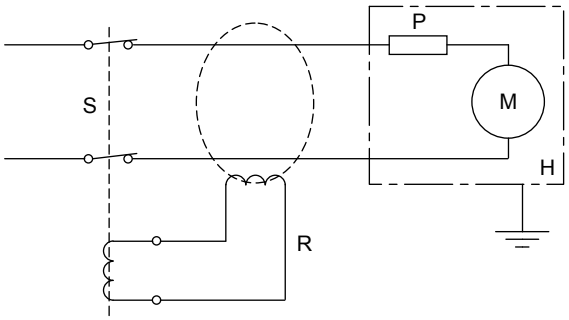
30.2.2 Not applicable.

31 Resistance to rusting

This clause of Part 1 is applicable only to parts which are outside the **housing**.

32 Radiation, toxicity and similar hazards

This clause of Part 1 is not applicable.



Key

S	Supply
H	**Housing**
R	Residual current device that can detect a.c. or a.c. with d.c. components, max. $I_{\Delta n}$ = 30 mA r.m.s. or d.c. max. $I_{\Delta n}$ = 30 mA
P	**Motor-compressor protection system** (external or internal)
M	**Motor-compressor**

Figure 101 – Supply circuit for the locked-rotor test of a single-phase motor-compressor