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Edition 4.2 2009-01

INTERNATIONAL STANDARD

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



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INTERNATIONAL
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COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

HOUSEHOLD AND SIMILAR ELECTRICAL APPLIANCES – SAFETY –

Part 2-34: Particular requirements for motor-compressors

FOREWORD

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

This consolidated version of IEC 60335-2-34 consists of the fourth edition (2002) [documents 61C/214/FDIS and 61C/217/RVD], its amendment 1 (2004) [documents 61C/283A/FDIS and 61C/298/RVD] and its amendment 2 (2008) [documents 61C/431/FDIS and 61C/435/RVD].

The technical content is therefore identical to the base edition and its amendments and has been prepared for user convenience.

It bears the edition number 4.2.

A vertical line in the margin shows where the base publication has been modified by amendments 1 and 2.

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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 fourth edition (2001) 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.

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 committee has decided that the contents of the base publication and its amendments will remain unchanged until the maintenance result 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.

2 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 the amendment 2 be adopted for implementation nationally not earlier than 12 months or later than 36 months from the date of publication.

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

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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
2 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.

2 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.

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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.

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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**.

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.

NOTE 102 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 103 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 104 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 105 If **motor-compressors** for refrigerant R744 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.

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2 Normative references

This clause of Part 1 is applicable except as follows.

Modification:

Replace IEC 60252, *AC Motor capacitors by* IEC 60252-1, *AC motor capacitors – Part 1: General – Performance, testing and rating – Safety requirements – Guide for installation and operation*

3 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. 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. 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. This control carries **motor-compressor** current and is sensitive to one or both of the following:

– **motor-compressor** temperature;

– **motor-compressor** current

NOTE 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
2 **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. The control carries **motor-compressor** current and is sensitive to one or both of the following:

– **motor-compressor** temperature;

– **motor-compressor** current

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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:

2

– **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

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.

2 **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 (DP)
gauge pressure that has been assigned to a **transcritical refrigeration system**

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 This device has no provisions for setting by the end user.

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.

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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.*

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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**.*

6 Classification

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

6.101 Motor-compressors are classified as being tested with Annex AA or without 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.*

2 **Motor-compressors** using refrigerant R744 shall not be classified as being tested with 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 may 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 may be necessary.

Compliance is checked by inspection and by the relevant tests.

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2 **6.103 Motor-compressors** are classified as being protected by **protective electronic circuits** or not being protected by **protective electronic circuits**.

NOTE This does not preclude the **protective electronic circuits** being provided in the end product.

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.

7.5 Not applicable.

7.7 Not applicable.

7.12 Not applicable, except 7.12.1 which is applicable.

7.13 Not applicable.

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 may 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.

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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 19.101, 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 *Modification:*

2 *If the tests of this subclause 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.

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*

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2 *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 of this subclause have to be carried out, they must be carried out in the end product application.

NOTE 101 The application of these tests in this part 2 is not mandatory.

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 of this clause.*

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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 may 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 may 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.

2 NOTE 3 This test may 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 the circuit shown in Figure 101 and 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 may be carried out on a separate sample.

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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.*

2 *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.*

2 *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 may 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**.*

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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 may 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 ºC;*

– *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 three hours.

*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.

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22 Construction

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

22.2 Not applicable.

22.5 Not applicable.

22.7 *Replacement:*

2 **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).*

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

Saturated vapour pressure at 70 °C = 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.*

NOTE 102 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		Test pressure	
		MPa	(bar)
Non-transcritical			
CCl_2F_2	R-12	6,0	(60)
CF_3CH_2F	R-134a	6,5	(65)
$CHCl_2F_2$	R-22	10,5	(105)
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-507	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)

*A **housing** which is exposed only to low side pressure shall, for both subcritical and transcritical applications, be subjected to a pressure equal to 5 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).*

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2 NOTE 103 Example of test pressure calculation for R-22 (subcritical):

Saturated vapour pressure at 20 °C = 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).

NOTE 104 The test values for some refrigerants are given in Table 102. The values may, however, not be high enough for some applications.

Table 102 – Minimum low side test pressures

Refrigerant		Test pressure	
		MPa	(bar)
Non-transcritical			
CCl_2F_2	R-12	2,5	(25)
CF_3CH_2F	R-134a	2,5	(25)
$CHCl_2F_2$	R-22	4,2	(42)
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-507	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)

NOTE 105 Further information relating to refrigerant number designations may be obtained from ANSI/ASHRAE 34.

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 106 All pressures are gauge pressure.

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22.9 *Addition:*

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

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

22.14 Not applicable.

22.21 *Addition:*

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

2 **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.

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.

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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 compressor housing.

29.1.1 *Addition:*

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

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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

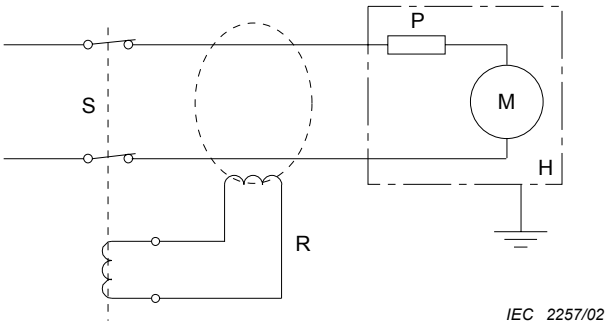
This clause of Part 1 is applicable only to parts which are outside the **housing**.

32 Radiation, toxicity and similar hazards

This clause of Part 1 is not applicable.

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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**

NOTE 1 The circuit must be modified for three-phase **motor-compressors**

NOTE 2 Care has to be taken to complete the earthing system to permit the correct operation of the residual current device.

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

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Annexes

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

Annex C
(normative)

Aging test on motors

This annex of Part 1 is not applicable.

Annex D
(normative)

Alternative requirements for protected motor units

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 *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 at* ***rated voltage*** *and under the appropriate running overload conditions specified in Table AA.1 for a period of not less than 2 h.*

NOTE 1 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 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 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 may be required, as the exact effect of the additional cooling means may not be able to be simulated.

NOTE 4 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 If the motor winding temperature of the **motor-compressor** does not exceed the maximum value specified in clause AA.3 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 60335-2-24, IEC 60335-2-40 and IEC 60335-2-75.

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AA.2 *The **motor-compressor** including its protection system and 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, the **motor-compressor** being supplied at 1,06 times the **rated voltage**. If the **motor-compressor** cooling capacity is variable it is adjusted to its maximum value. The test is continued until steady conditions are reached.*

NOTE 1 Special arrangements for the **motor-compressor control system** may 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.

*The test is then repeated with a supply voltage equal to 0,94 times the **rated voltage**.*

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

Application category	Evaporation temperature	Condensation temperature	Motor-compressor ambient temperature	Return gas temperature
	°C	°C	°C	°C
Low back pressure	–15	+65	+43	+43
Medium back pressure	0	+65	+43	+25
High back pressure	+12	+65	+43	+25

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** may 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 °C 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 the test

– *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**, if any, 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 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 following tests are conducted to cause the **motor-compressor protection system** to operate or to reach steady conditions with the **motor-compressor** in the stalled or running condition.*

*The **motor-compressor** is operated under the conditions of clause AA.2, but with the supply voltage reduced to 0,85 times the **rated voltage**, until the **motor-compressor protection system** operates or steady conditions are reached.*

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*If a **motor-compressor protection system** does not operate, the voltage is reduced in steps of 4 % ± 1 % of the **rated voltage** 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;*

– *the **motor-compressor** continues to run regardless of further voltage reductions 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 none of these three conditions shall the **motor-compressor** winding temperature exceed 160 ºC for **motor-compressors** with synthetic insulation and 150 ºC for **motor-compressors** with cellulosic insulation.*

NOTE 2 The values of 160 ºC and 150 ºC have been chosen, taking into account the temperature limits specified in existing IEC publications such as IEC 60335-2-24, IEC 60335-2-40 and IEC 60335-2-75,

– for **motor-compressor** windings under abnormal conditions, during which the **motor-compressor protection system** may operate, and

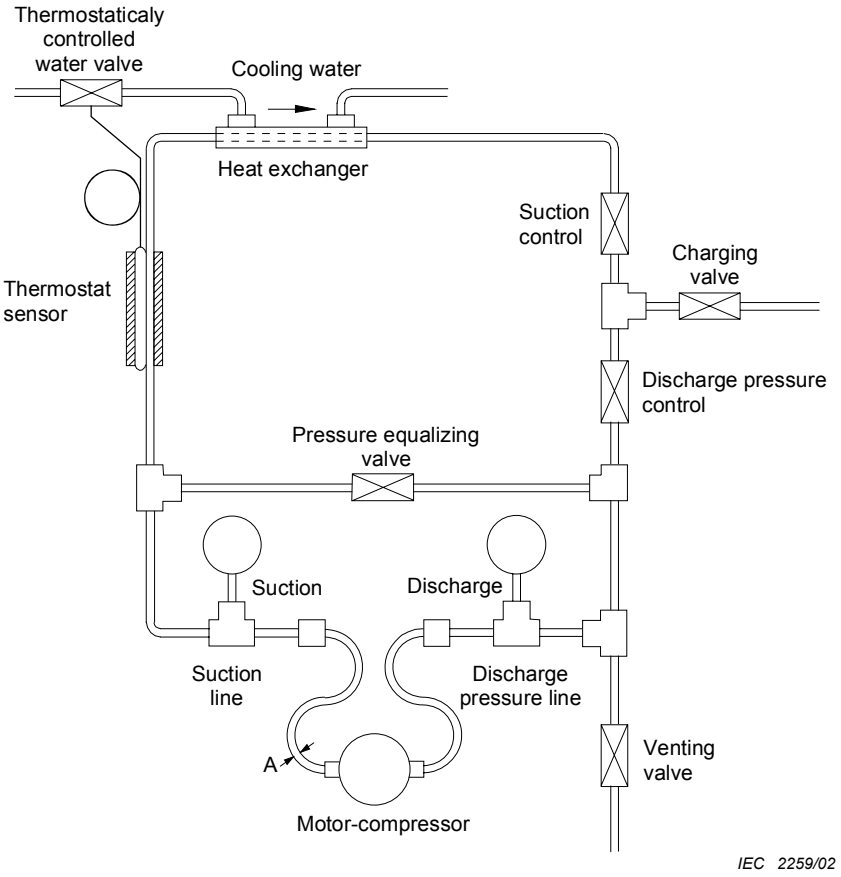
– for **motor-compressor** windings under normal conditions, a temperature limit exceeding by 20 K the allowed temperature limit, during which the **motor-compressor protection system** shall not operate.

NOTE 3 It is recommended that the resistance of the windings at the end of the test be determined by taking resistance measurements as soon as possible after switching off, and then at short intervals so that a curve of resistance against time can be plotted for ascertaining the resistance at the instant of switching off.

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.

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

NOTE 2 The complete substitute cooling system may 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 may be added as needed, as long as the specified temperatures and conditions of Table AA.1 are maintained. A replaceable filter dryer may 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**, may 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 shall be incorporated in the substitute cooling system, as recommended by the **motor-compressor** manufacturer.

Figure AA.1 – Substitute refrigeration circuit

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Bibliography

2 The bibliography of Part 1 is applicable except as follows.

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

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

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

ANSI/ASHRAE 34: *Number designation and safety classification of refrigerants*

2 ISO 13732-1, *Ergonomics of the thermal environment – Methods for the assessment of human responses to contact with surfaces – Part 1: Hot surfaces*

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