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Household frost-free refrigerating appliances — Refrigerators, refrigerator-freezers, frozen food storage cabinets and food freezers cooled by internal forced air circulation — Characteristics and test methods

Appareils de réfrigération ménagers à air pulsé — Réfrigérateurs, réfrigérateurs-congélateurs, conservateurs de denrées congelées et congélateurs à air pulsé intérieur — Caractéristiques et méthodes d'essai

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 8561 was prepared by Technical Committee ISO/TC 86, *Refrigeration*, Subcommittee SC 5, *Construction and testing of household refrigerators*.

Annexes A and B of this International Standard are for information only.

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Household frost-free refrigerating appliances — Refrigerators, refrigerator-freezers, frozen food storage cabinets and food freezers cooled by internal forced air circulation — Characteristics and test methods

1 Scope

This International Standard specifies the essential characteristics for household frozen food storage cabinets and food freezers cooled by internal forced air circulation and for household refrigerators with or without cellar, ice-making or frozen food storage compartments, and of refrigerator-freezers with or without cellar compartment and with at least the food freezer and or frozen food storage compartment(s) cooled by internal forced air circulation, which are wholly factory assembled, and lays down the methods of test for the checking of these characteristics.

Appliances with one refrigerating system in which there are compartments, some cooled by forced air circulation and others by natural convection, shall be tested in accordance with this International Standard.

Compartments cooled by natural convection but having a separate independent refrigerating system shall be tested in accordance with the applicable referenced standard.

However, all compartments are automatically defrosted with automatic disposal of the defrost water.

This International Standard does not apply to household refrigerators (which are covered in ISO 7371), refrigerator-freezers (which are covered in ISO 8187) or frozen food storage cabinets and food freezers (which are covered in ISO 5155) not cooled by internal forced air circulation.

The tests described in this International Standard are type tests. When it is necessary to verify the performance of a refrigerating appliance of a given type in relation to this International Standard, all the tests described should in principle be applied to one and the same unit.

These tests can also be made individually for the study of a particular characteristic.

Where no test method is specified, the particular requirement concerned is to be considered as a recommendation.

The electrical and mechanical safety requirements applicable to household refrigerating appliances are specified in IEC 335-2-24. This International Standard does not apply to household frost-free refrigerating appliances operating on energy sources other than electricity.

Additional safety requirements applicable to the refrigerating systems of household refrigerating appliances are given in ISO 5149.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 534:1988, *Paper and board — Determination of thickness and apparent bulk density or apparent sheet density.*

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ISO 817:—[1], *Refrigerants — Number designation.*

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

IEC 335-2-24:1992, *Safety of household and similar electrical appliances — Part 2: Particular requirements for refrigerators, food freezers and ice-makers.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 household frost-free appliance: Insulated cabinet of suitable volume and equipment for household use, cooled by one or more energy-consuming means, in which all compartments are automatically defrosted with automatic disposal of the defrost water, and at least one compartment is cooled by a frost-free system (see 3.1.5).

3.1.1 household frost-free refrigerator (hereinafter referred to as "refrigerator"): Frost-free appliance having one or more compartments intended for the preservation of food, one at least of which is suitable for the storage of fresh food.

3.1.2 household frost-free refrigerator-freezer (hereinafter referred to as "refrigerator-freezer"): Frost-free appliance having two or more compartments.

At least one compartment (the fresh food storage compartment) is suitable for the storage of fresh food, and at least one compartment (the food freezer compartment) is suitable for freezing fresh food and for the storage of frozen food under "three star" storage conditions (see 3.2.5.4).

3.1.2.1 household refrigerator-freezer type I: A refrigerator-freezer having a single temperature control device for regulating the temperatures of the fresh food storage and food freezer compartments.[2]

3.1.2.2 household refrigerator-freezer type II: A refrigerator-freezer having the means for separate regulation of the temperatures of the fresh food storage and food freezer compartments.[2]

3.1.3 household frost-free frozen food storage cabinet (hereinafter referred to as "frozen food storage cabinet"): Frost-free appliance having one or more compartments which is (are) suitable for the storage of frozen food under "three star" storage conditions (see 3.2.5.4).[3]

3.1.4 household frost-free food freezer (hereinafter referred to as "food freezer"): Frost-free appliance having one or more compartments suitable for freezing, from + 25 °C to − 18 °C for class SN, N and ST appliances, + 32 °C to − 18 °C for class T appliances (see clause 4), a quantity of at least 4,5 kg of test packages per 100 l of its storage volume in 24 h, and in no case less than 2 kg, under the test conditions specified in clause 17, and which is also suitable for the storage of frozen food under "three star" storage conditions (see 3.2.5.4).[3]

NOTE 1 From the point of view of installation, there are various types of household refrigerating appliances: freestanding, wall-mounted, built-in, etc.

3.1.5 frost-free system: System in which cooling is provided by forced air circulation and the evaporator(s) is (are) defrosted by an automatic defrost system. Characteristics of the "frost-free" system are:

a) the system is automatically operated to prevent the permanent formation of frost on all refrigerated surfaces;

b) no accumulation of ice or frost forms on the stored food;

c) storage temperatures in the fresh food compartment, the frozen food storage and/or freezer compartment and the cellar compartment (if any) are maintained within the limits specified in this International Standard;

d) the water from defrosting is disposed of automatically.

3.2 Compartments and sections

3.2.1 fresh food storage compartment: Compartment intended for the storage of unfrozen food, which may be itself divided into sub-compartments, and in which the temperatures can be maintained in accordance with 6.2.1.

1) To be published. (Revision of ISO 817:1974)

2) In the case of a cellar compartment there can be an additional means for regulating the temperature of that compartment.

3) In certain instances, "two star" sections and/or compartments are permitted within the appliance (see 7.2.6).

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3.2.2 cellar compartment: Compartment intended for the storage of particular foods or beverages at a temperature warmer than that of the fresh food storage compartment, and in which the temperatures can be maintained in accordance with 6.2.1.

3.2.3 low-temperature compartment: Compartment which may be either

— an ice-making compartment; or

— a frozen food storage compartment.

3.2.4 ice-making compartment: Compartment intended specifically for the freezing and storage of water ice-cubes.

3.2.5 frozen food storage compartments: Compartments intended specifically for the storage of frozen food. They are classified according to their temperature, as follows.

3.2.5.1 "one star" compartment: Compartment in which the storage temperature (see 3.4.3.2), measured as described in clause 13, is not warmer than − 6 °C.

3.2.5.2 "two star" compartment: Compartment in which the storage temperature (see 3.4.3.2), measured as described in clause 13, is not warmer than − 12 °C.

3.2.5.3 "two star" section: Part of a food freezer compartment (or cabinet) or of a "three star" compartment (or cabinet) which is not self-contained (i.e. which does not have its own individual access door or lid), in which the storage temperature (see 3.4.3.2), measured as described in clause 13, is not warmer than − 12 °C (see 7.2.6).

3.2.5.4 "three star" compartment: Compartment in which the storage temperature (see 3.4.3.2), measured as described in clause 13, is not warmer than − 18 °C.[4)]

3.2.6 food freezer compartment: Compartment suitable for freezing from + 25 °C to − 18 °C for class SN, N and ST appliances, and from + 32 °C to − 18 °C for class T appliances (see clause 4), a quantity of at least 4,5 kg of test packages per 100 l of its storage volume in 24 h, and in no case less than 2 kg, under the test conditions specified in clause 17, and which is also suitable for the storage of frozen food under "three star" storage conditions (see 3.2.5.4).[4)]

3.3 General definitions

3.3.1 top-opening type: Appliance in which the compartment(s) is (are) accessible from the top.

3.3.2 upright type: Appliance in which the compartment(s) is (are) accessible from the front.

3.3.3 overall dimensions (doors or lids closed)**:** Measurements of the rectangular parallelepiped, whose base is horizontal, within which the appliance is inscribed to include the complete appliance except for the handle, the protrusion of which, if any, is to be specified separately.

3.3.4 overall space required in use (doors or lids open)**:** Overall dimensions including the handle, increased by the space necessary for free circulation of the cooling air when the appliance is in service, plus the space necessary to allow opening of the means of access to that minimum angle permitting removal of all removable parts such as containers and shelves (see figure 1).

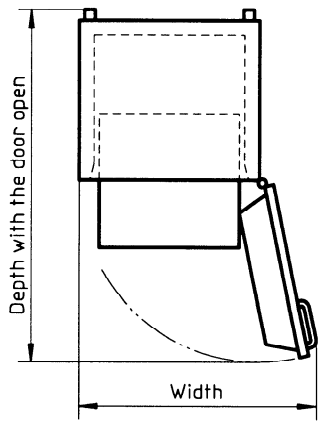

Figure 1 — Overall space required in use (upright type)

3.3.5 Volumes

3.3.5.1 gross volume: The volume within the inside walls of the appliance, or of a compartment with external door, without internal fittings, doors or lids being closed.

4) In certain instances, "two star" sections and/or compartments are permitted within the compartment (or cabinet) (see 7.2.6).

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The gross volume is calculated by subtracting from the total volume the volume occupied by air ducts, evaporator, fan and other associated accessories.

3.3.5.2 rated gross volume: Gross volume stated by the manufacturer.

3.3.5.3 total gross volume: Sum of the gross volumes of the fresh food storage compartment(s), low-temperature compartment(s), food freezer compartment [including any "two star" section(s), and/or compartment(s) contained therein], and cellar compartment(s), as applicable, even if their doors or lids are independent.

3.3.5.4 rated total gross volume: Total gross volume stated by the manufacturer.

3.3.5.5 storage volume: That part of the gross volume of any compartment which remains after deduction of the volume of components and spaces recognized as unusable for the storage of food, determined by the method given in 7.2.

3.3.5.6 rated storage volume: Storage volume stated by the manufacturer.

3.3.5.7 total storage volume: Sum of the storage volumes of the appliance, comprising the storage volumes of the fresh food storage compartment(s), low-temperature compartment(s), food freezer compartment [including any "two star" section(s) and/or compartment(s) contained therein] and cellar compartment(s), as applicable.

3.3.5.8 rated total storage volume: Total storage volume stated by the manufacturer.

3.3.6 Storage surface

3.3.6.1 shelf: For the purpose of this International Standard, a shelf is any horizontal surface (shelves, partitions, etc.) on which food can be placed.

It may be formed by one component or by components fitted side by side, which may be fixed or removable.

3.3.6.2 storage shelf area: Sum of the horizontal projections of the storage surfaces within the storage volume including door shelves and the bottom of each compartment, determined in accordance with 7.3.

3.3.6.3 rated storage shelf area: Storage shelf area stated by the manufacturer.

3.3.7 load limit(s): Surface enveloping the frozen food storage volume(s).

3.3.8 load limit line(s): Permanent mark(s) indicating the limits of "three star" frozen food storage volume(s).

3.4 Definitions relating to some performance characteristics

3.4.1 energy consumption: Consumption of an appliance over a period of 24 h, running under stable operating conditions at an ambient temperature of + 25 °C (in the case of class SN, class N and class ST appliances) or + 32 °C (in the case of class T appliances (see clause 4) and measured under the conditions specified in clause 15.

NOTE 2 In some countries a different method for the measurement of energy consumption is required by low (see annex A).

3.4.2 rated energy consumption: Energy consumption stated by the manufacturer.

3.4.3 Storage temperatures

3.4.3.1 fresh food storage temperature, t_m: Arithmetical average of the instantaneous temperatures t_1, t_2 and t_3 measured in "M" packages (see 3.4.6) and placed at given points in the fresh food storage compartment as specified in 8.5 .

$t_{m,max}$ is the maximum value of t_m.

3.4.3.2 frozen food storage temperature, t^{***}, t^{**}, t^{*} (as appropriate): Maximum temperature of the warmest "M" package of a load placed in storage as specified in 8.6.

3.4.3.3 cellar compartment temperature, t_{cm}: Arithmetical average of the instantaneous temperatures t_{c1}, t_{c2} and t_{c3} (as appropriate) measured in "M" packages (see 3.4.6) and placed at given points in the cellar compartment as specified in 8.5.

$t_{cm,max}$ is the maximum value of t_{cm}.

3.4.4 freezing capacity: Mass of test packages whose temperature (taken as the instantaneous arithmetical mean temperature of all the "M" packages) can be lowered from the loading temperature of + 25 °C or + 32 °C (see 3.1.4 or 3.2.6) to − 18 °C in 24 h under the test conditions specified in clause 17. The freezing capacity is expressed in kilograms.

3.4.4.1 rated freezing capacity: Freezing capacity stated by the manufacturer.

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3.4.5 Defrosting

3.4.5.1 automatically defrosted: An evaporator is automatically defrosted where no action is necessary by the user to intiate the removal of frost accumulation nor to restore normal operation, and where the disposal of the defrost water is automatic.

3.4.5.2 automatic disposal of defrost water: Disposal of defrost water is automatic where the removal and the evaporation of the defrost water does not require any action by the user.

3.4.6 "M" package: A test package in accordance with 8.2, of dimensions 50 mm × 100 mm × 100 mm, fitted with a temperature sensor at its geometric centre.

3.4.7 Cycles

3.4.7.1 operating cycle: That period which commences at the initiation of a defrosting cycle and terminates at the moment of initiation of the next defrosting cycle.

3.4.7.2 defrosting cycle: The period between the moment when the means of defrosting the evaporator(s) is switched on and the moment when the refrigeration process is re-established.

3.4.8 stable operating conditions: Stable operating conditions exist when the appliance has been left running for a minimum time according to the manufacturer's instruction without any adjustment of temperature control setting(s) during this time, and when there is no marked trend away from the storage temperatures (see table 2) after this time.

3.4.9 percentage running time, R' (apparatus with on/off control for the refrigerating source)**:** Under given conditions of ambient temperature and of internal storage temperature, the ratio

$$R' = \frac{d'}{D'} \times 100$$

where

d' is the duration of the refrigerating system operation during an operating cycle (see 3.4.7.1);

D' is the total duration of the operating cycle minus the duration of the defrosting cycle (see 3.4.7.2), even if defrosting occurs by a hot-gas system (see also figure 2).

When calculating the percentage running time for an appliance in accordance with this International Standard, the duration of the defrosting cycle must be taken into account, R' has been introduced in order to have a clear distinction between this and the percentage running time R of conventional appliances.

For appliances with a hot-gas defrosting system, the time required for hot-gas defrosting shall not be included in the running time of the refrigerating unit.

3.4.10 ice-making capacity: Quantity of ice the appliance is capable of producing within 24 h, or the time necessary for the freezing of the water in the ice tray(s) supplied with the appliance.

3.4.11 ambient temperature: Temperature in the space surrounding the appliance under test. It is the arithmetical average of the mean value of temperatures t_{a1} and t_{a2}, measured at two points located 350 mm from the vertical centreline of the side walls of the appliance at 1 m above the floor line.

3.4.12 temperature rise time: Period between the moment when, under specified test conditions, the temperature of the warmest "M" package in the food freezer compartment (or cabinet) or in any "three star" compartment (or cabinet) reaches − 18 °C to the moment when any of the "M" packages (excluding any "two star" sections) first reaches a temperature of − 9 °C when the operation of the refrigerating system is interrupted.

3.5 Definitions relating to the refrigerating system

3.5.1 refrigerant: Fluid used for heat transfer in a refrigerating system, which absorbs heat at a low temperature and a low pressure of the fluid and rejects heat at a higher temperature and a higher pressure of the fluid, usually involving changes of state of the fluid.

3.5.2 cooling device: Device containing the evaporator or in thermal contact with the evaporator; it may be a device with fins or may be suitably shaped for the storage of frozen food or water ice-cubes.

3.6 Definitions relating to compression-type appliances

3.6.1 compression-type appliance: Appliance in which refrigeration is effected by the vaporization at low pressure in a heat exchanger (evaporator) of a liquid refrigerant, the vapour thus formed being restored to the liquid state by mechanical compression to a higher pressure and subsequent cooling in another heat exchanger (condenser).

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3.6.2 hermetically sealed motor-driven refrigerating compressor: Motor-compressor in which the compressor and the electric motor (or its moving parts at least) are enclosed in a shell rendered gastight by welding, brazing or other means such that dismantling is not normally possible after assembly. It does not include moving parts outside the shell.

3.6.3 hermetically sealed compressor refrigerating system: Complete system, essentially comprising a hermetically sealed motor-driven compressor, a condenser, a pressure-reducing device, an evaporator, and all other parts containing refrigerant permanently interconnected by the manufacturer by welding, brazing or other means.

3.6.4 refrigerant compressor: Mechanically operated component which withdraws refrigerant vapour from the evaporator and discharges it at a higher pressure to the condenser.

3.6.5 expansion device: Device in which the pressure of the refrigerant is reduced from that of the condensed liquid to that of the evaporator.

3.6.6 condenser: Heat exchanger in which, after compression, vaporized refrigerant is liquefied by rejecting heat to an external cooling medium.

3.6.7 evaporator: Heat exchanger in which, after expansion, the liquid refrigerant is vaporized by absorbing heat from the medium to be refrigerated.

3.6.8 thermostat: Device which automatically regulates the operation of a refrigerating system according to the temperature of an evaporator or of a compartment (or cabinet).

3.6.9 fan: Device which provides cooling by means of a forced air stream to a condenser and/or to one or more compartments of the appliance.

3.6.10 defrost timer: Device which controls the initiation, duration and time lapse between defrost cycles.

3.6.11 demand defrost: System of defrost control in which the initiation of the defrost cycle is controlled by the rate of accumulation of frost on the evaporator surfaces.

3.6.12 defrost heater: Device which provides heat to the frost formed on the evaporator in order to facilitate the melting and removal of the ice.

4 Classification

With respect to the ability of appliances to operate in extreme ambient temperatures, this International Standard relates to the four climate classes given in table 1.

Table 1 — Climate classes

Values in degrees Celsius

Class	Symbol	Range of ambient temperatures in which the appliances are intended to be used, and for which the required storage temperatures shall be fulfilled (see 6.2.1)
Extended temperate	SN	+ 10 to + 32
Temperate	N	+ 16 to + 32
Subtropical	ST	+ 18 to + 38
Tropical	T	+ 18 to + 43

5 Materials, design and manufacture

5.1 General

Appliances shall be constructed in such a manner as to ensure adequate performance and durability in use. Their performance in use is checked by applying a series of relevant tests.

This clause defines some characteristics which are not tested but to which the attention of the manufacturer is drawn.

5.2 Materials and finishes

Materials used inside appliances shall not transmit odours or taste to food. When testing in accordance with clause 19, the mean value of the individual results during each evaluation for odour and taste shall not exceed mark 1.

Materials used inside appliances shall not contaminate food placed in contact with them nor transmit poisonous substances to food. They shall be resistant to the action of moisture and food acids.

All surface finishes shall, for the purpose intended, be resistant to impact, sufficiently hard, colour-fast, smooth, easily washable, and resistant to damage by moisture and by food acids.

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5.3 Thermal insulation and airtightness

The thermal insulation of the appliance should be efficient and permanently maintained. In particular, the insulating material shall not be subject to shrinkage and shall not allow, under normal working conditions, an excessive accumulation of moisture.

No running water shall appear externally when the appliance is subjected to the water vapour condensation test specified in clause 14.

When the door or lid is closed, there shall be no abnormal ingress of air into the interior.

A strip of paper shall not slide freely when door or lid seals are subjected to the airtightness test specified in clause 9.

5.4 Doors, lids and fittings

Hinges and handles shall be strong and resistant to corrosion.

External doors and lids of fresh food storage compartments and cellar compartments shall withstand 100 000 openings and closings without deterioration which may be prejudicial to the airtightness of the appliance when subjected to the durability test of clause 11.

In the case of frozen food storage cabinets, food freezers and appliances with the food freezer compartment and the frozen food storage compartment, if any, having a separate access door or lid, the hinges and handles of the door or lid of that compartment (or cabinet) shall withstand 10 000 openings and closings.

The fastening system shall be such as to enable the door or lid to be easily closed and opened. It shall be efficient and capable of maintaining its proper function.

For appliances having any compartment or section with a volume equal to or greater than 60 l, it shall be possible to open the door or lid of that compartment from the inside with a force not exceeding 70 N when subjected to the test specified in clause 10. The volume of any compartment (or cabinet) or section shall be determined when all shelves, partitions and other internal components removable without the aid of a tool have been removed. However, if the door or lid is provided with a mechanical latch which can be locked by a removable key, and the door or lid cannot be closed with the key turned to the locked position, this requirement applies only when the latch is unlocked, provided that the appliance is accompanied by an instruction stating that the key shall be kept out of the reach of children and not kept in the vicinity of the appliance.

5.5 Shelves and containers

Shelves, containers and similar components shall have adequate mechanical strength. Those used for storing food shall withstand the loading test specified in clause 12 without showing such distortion that they could no longer fulfil their intended function. In particular, sliding or revolving components shall be capable of their full movement when loaded.

Shelves, containers and similar components which are intended to be removable should be easily removable.

5.6 Disposal of defrost water

A means shall be provided for completely collecting the defrost water in an external receptacle wherein the defrost water is evaporated.

The defrost water receptacle should have adequate volume and should have adequate evaporating means.

Any drainage system shall be designed to ensure its proper function. It shall be easily accessible for the clearing of any blockage, and shall be designed so as to prevent any undue ingress of air into the food storage compartment(s) (or cabinets).

5.7 Refrigerating system

5.7.1 The mechanical operation of the appliance should not give rise to undue noise or vibration.

5.7.2 The design of the condenser should be such as to reduce to a minimum the accumulation of dust.

5.7.3 The evaporator shall be so designed or protected so that it will not suffer any damage during the normal use of the appliance.

The heat exchange surfaces shall be made of corrosion-resistant material, or shall be finished with a corrosion-proof non-poisonous coating resistant to temperature changes and alternating frosting and defrosting.

5.7.4 The means of adjustment of temperature control devices, if intended to be adjusted by the user, should be readily accessible, and their function shall be such as to enable the appliance to meet the requirements of the performance tests.

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5.7.5 Pipes and connections to moving or resiliently mounted parts should be arranged so as not to generate noise, not to touch nor to transmit vibrations to other parts, and should be so designed as to prevent failure due to fatigue. All other pipes and connections should be securely anchored. Where necessary, pipes and valves should be properly insulated.

5.7.6 Suitable means should be provided to prevent water condensed on cold parts from affecting the operation of the unit or its controls, or from causing any other damage to the appliance and its surroundings.

6 Required characteristics

6.1 Volumes and areas

6.1.1 Rated gross volume

The measured gross volume shall not be less than the rated gross volume by more than 3 % of the latter or 1 litre, whichever is the greater value.

6.1.2 Rated storage volume

The measured storage volume shall not be less than the rated storage volume by more than 3 % of the latter or 1 litre, whichever is the greater value.

6.1.3 Rated cellar compartment storage volume

The rated storage volume of any cellar compartment shall not be greater than the rated storage volume of the fresh food storage compartment. Where the volumes of the cellar compartment and fresh food storage compartment are adjustable relative to one another by the user, this requirement shall apply when the cellar compartment is adjusted to its minimum volume.

6.1.4 Rated storage shelf area

The measured storage shelf area, including that of any cellar compartment, shall not be less than the rated storage shelf area by more than 3 % of the latter.

6.2 Performance characteristics

6.2.1 Storage temperatures

Under the conditions specified in clause 13, the appliance shall be capable of maintaining, simultaneously, the required storage temperatures in the different compartments as shown in table 2 for the appropriate climate class.

Appliances having additional frozen food storage compartments shall comply simultaneously with the conditions specified in table 2 for the appropriate cli-

Table 2 — Storage temperatures for all climate classes (see clause 4)

Values in degrees Celsius

		Fresh food storage compartment (see 3.4.3.1)		**Frozen food storage or food freezer compartment, cabinet or section, as applicable** (see 3.4.3.2 and 7.2.6)			**Cellar compartment** (see 3.4.3.3)
		t_1, t_2, t_3	$t_{m,max}$	t^{***}	t^{**}	t^{*}	$t_{cm,max}$
I	Storage temperatures	$0 \leqslant t_1, t_2, t_3 \leqslant +10$	$\leqslant +5$	$\leqslant -18$	$\leqslant -12$	$\leqslant -6$	$+8 \leqslant t_{cm,max} \leqslant +14$
II	Permitted temperature deviations (defrost cycle)	$0 \leqslant t_1, t_2, t_3 \leqslant +10$	$\leqslant +7$	$\leqslant -15$	$\leqslant -12$	$\leqslant -6$	$+8 \leqslant t_{cm,max} \leqslant +14$

NOTES

1 The duration of the temperature deviation above the storage temperature (line "I") as a result of a defrost cycle shall not be greater than 4 h or 20 % of the duration of the operating cycle, whichever is the shorter.

2 In the case of t^{***}, the duration of the deviation shall be measured from the moment when the first "M" package temperature exceeds − 18 °C to that moment when the last "M" package temperature returns permanently to − 18 °C or colder.

3 In the case of t_m, the duration of the deviation shall be measured from the moment when t_m exceeds + 5 °C to that moment when t_m returns permanently to + 5 °C or colder.

4 These two deviations need not occur simultaneously (see figure 2 for example).

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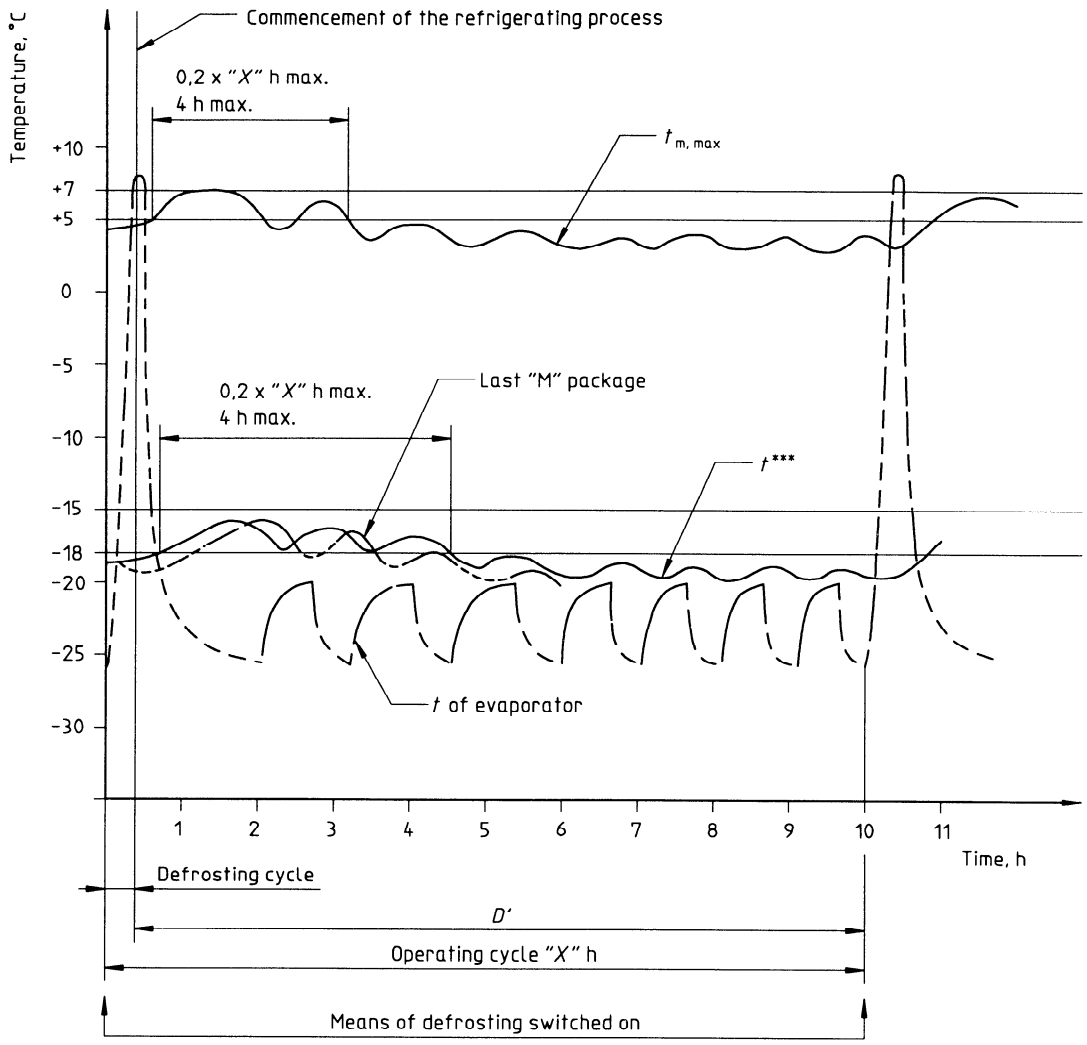

Figure 2 — Example of an operating cycle of a frost-free refrigerator-freezer

mate class and with the relevant classification temperature specified in 3.2.5.

6.2.2 Freezing capacity (if applicable)

The freezing capacity measured in accordance with clause 17 on the first appliance tested shall not be less than the rated freezing capacity by more than 15 % of the latter.

If the result of the test carried out on the first appliance is less than the declared value minus 15 %, the test shall be carried out on a further three appliances.

The arithmetical mean of the freezing capacity values of these three appliances shall be equal to or greater than the declared value minus 10 %.

The minimum freezing capacity in accordance with 3.1.4 or 3.2.6 and the requirement of 17.1.3.4, as appropriate, shall be respected.

6.2.3 Energy consumption

If the energy consumption is stated by the manufacturer, the value measured in the energy-consumption test on the first appliance tested shall not be greater than the rated energy consumption by more than 15 % of the latter.

If the result of the test carried out on the first appliance is greater than the declared value plus 15 %, the test shall be carried out on a further three appliances.

The arithmetical mean of the energy-consumption values of these three appliances shall be equal to or less than the declared value plus 10 %.

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6.2.4 Ice making (if applicable)

If the ice-making capacity is stated by the manufacturer, the value measured in accordance with clause 18 shall not be less than the declared value by more than 15 % of the latter.

If the ice-making capacity obtained from the first test is less than the declared value minus 15 %, the test shall be carried out on a further three appliances.

The arithmetical mean of the ice-making capacity values of these three appliances shall be equal to or greater than the declared value minus 10 %.

6.2.5 Temperature rise time (if applicable)

If the temperature rise time is stated by the manufacturer, the value measured in accordance with clause 16 on the first appliance tested shall not be shorter than the declared value by more than 15 % of the latter.

If the result of the test on the first appliance is less than the declared value minus 15 %, the test shall be carried out on a further three appliances. The arithmetical mean of the periods of temperature rise of these three appliances shall be equal to or greater than the declared value minus 10 %.

7 Determination of linear dimensions, volumes and areas

The measurements are carried out on the appliance as delivered and not operating. If there is a cellar compartment, the volume of which is adjustable, the measurements shall be made with this compartment adjusted to both its minimum and maximum volumes (see 6.1.3).

7.1 Determination of linear dimensions

Linear dimensions shall be measured to the nearest millimetre.

7.2 Determination of volumes

Volumes shall be expressed in a whole number of cubic decimetres or of litres.

7.2.1 Determination of gross volume

The gross volume shall be calculated by dividing the total volume into convenient units of volumes of geometric shapes which can easily be measured.

When the gross volume is determined, internal fittings such as shelves, removable partitions, containers, evaporators, thermostats and interior light housings shall be considered as not being in place. However, the gross volume shall take into account the exact shapes of the walls if they contain depressions or projections.

Any volume which is inaccessible because of air ducts, fans, evaporator and other associated accessories shall also be deducted [for examples see figures 18 a) to 18 d)].

7.2.2 Determination of the total storage volume

The total storage volume of the appliance shall be the sum of the storage volumes of the fresh food storage compartment(s), cellar compartment(s), ice-making compartment(s), frozen food storage compartment(s), and food freezer compartment(s), as applicable.

For the determination of storage volumes, the total volume of devices and of spaces considered unusable for the storage of food shall be deducted from the gross volume calculated in accordance with 7.2.1 [see 7.2.3 for fresh food storage compartments and cellar compartments, and 7.2.4 and 7.2.5 for low-temperature compartments (or cabinets) and food freezer compartment(s) (or cabinets), if applicable].

7.2.3 Storage volume of fresh food storage and cellar compartments (if applicable)

The storage volume of the fresh food storage and cellar compartments shall be the gross volume of the compartment minus

— the volume of the evaporator space, as defined in 7.2.3.1, if applicable;

— the volume of any housings (such as those for interior lights, thermostats and other devices);

— the volume of shelves, partitions, retainers and other accessories, whose wall thickness is greater than 13 mm, as defined in 7.2.7;

— the space between the inner door protrusion (dykes) and the inner liner of the fresh food storage compartment and cellar compartment.

Where the volumes of the cellar compartment and fresh food storage compartment are adjustable relative to one another by the user, the storage volumes of these compartments shall be determined with the cellar compartment adjusted to its minimum and maximum volumes.

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7.2.3.1 Volume of the evaporator space
(if applicable)

The volume of the evaporator space shall be the product of the depth, width and height, defined as follows.

7.2.3.1.1 Depth

The depth of the evaporator space shall be the mean horizontal distance between the front and rear surfaces of the enclosed space of the cabinet, measured at the level of the evaporator, unless there is a space provided in front of the evaporator for food storage.

Where a storage space is located in front of the evaporator, the depth of the evaporator space shall be taken as the mean horizontal distance from the inner surface of the rear of the enclosed space of the cabinet to the foremost part of the evaporator, or of the evaporator door if fitted.

7.2.3.1.2 Width

The width of the evaporator space shall be the overall horizontal width of the evaporator itself (neglecting suction headers near the top of the evaporator) or, if side ribs are used, the overall width including the ribs.

If there is less than 70 mm horizontal distance between the evaporator or the ribs and an inside wall of the enclosed space of the cabinet, such space shall be computed as part of the evaporator space.

7.2.3.1.3 Height

The height of the evaporator space shall be the mean vertical distance between the lower limit of the evaporator and the upper partition of the food storage compartment.

If the free space between the upper surface or top of the evaporator and the upper partition of the food storage compartment exceeds 40 mm, it shall be added to the storage volume of the fresh food storage compartment.

The evaporator height shall include any internal drip tray and/or drip collector.

7.2.4 Storage volume of ice-making compartments

The storage volume of the ice-making compartments shall be the sum of the volumes of all the compartments of this type in the appliance.

The volumes of these compartments shall be determined in a similar manner to that specified in 7.2.2 and 7.2.3, as appropriate.

7.2.5 Storage volume of food freezer compartments (or cabinets) and frozen food storage compartments (or cabinets)

For the determination of the storage volume of these compartments (or cabinets), the total volume which is unsuitable for storage shall be determined and then deducted from the gross volume determined as indicated in 7.2.1.

The total volume to be deducted shall comprise (for examples, see figure 19):

a) the volume of spaces situated outside any load limit (natural or marked by the manufacturer);

b) the volume of spaces provided specifically for making and storing ice, except in the case of appliances fitted with automatic icemakers, when the volume occupied by a removable storage bucket shall be included in the storage volume unless it is specified in the instructions for use that this volume is suitable for the storage of ice only;

c) the volume of spaces between the front stack(s) of the test package load (see 13.1.2.3) and the inner vertical surface of the door or any projection from the door where the horizontal distance between the front face of the stack(s) and the inner door surface or projection exceeds 15 mm;

d) the volume of all fixed components within the load limits;

e) the volume of spaces which are to be kept free for the good performance of the refrigerating system;

f) the volume of all removable parts which are stated by the manufacturer as necessary for the proper functioning of the appliance, except shelves and partitions whose thickness is not greater than 13 mm (see 7.2.7.1);

g) the volume rendered unusable by the use of removable parts (for example, baskets, shelves) necessary for obtaining satisfactory thermal and mechanical characteristics (see also 8.3.4);

h) any volume where the vertical clearance is less than 52 mm;

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i) any volume where it is impossible to place an "M" package of nominal dimensions.

NOTE 3 There is no equivalence between the value of the storage volume determined in accordance with the principles mentioned above and the volume of the packages loaded into the appliance for the storage and freezing tests. The free spaces specified in the test methods could be utilized in normal use and their volume should not be deducted from the gross volume when calculating the storage volume.

7.2.6 "Two star" sections and/or compartments in food freezer compartments (or cabinets) and in "three star" compartments (or cabinets)

A "two star" section or compartment is permitted both in the door and in the remaining storage volume when all the following conditions are met:

a) the "two star" section(s) or compartment(s) is (are) marked with the appropriate identification symbol;

b) the "two star" section(s) and/or compartment(s) is (are) separated from the "three star" volume by a partition, container, or similar construction;

c) the rated total "two star" storage volume does not exceed 20 % of the "three star" storage volume of the compartment (or cabinet), or 30 l, whichever is the smaller value;

d) the instructions for use give clear guidance regarding the "two star" section(s) and/or compartment(s);

e) the storage volume of the "two star" section(s) and/or compartment(s) is stated separately and is not included in the "three star" volume.

7.2.7 Volumes of shelves and partitions (for examples, see figure 20)

7.2.7.1 Thickness

The thickness of a shelf or partition shall be the mean distance between its outer surfaces.

Where the surface of a shelf or partition is corrugated or fitted with external pipe grids, the surface shall be the plane joining the outer apices of the corrugations or pipes, unless the distance between adjacent corrugations or pipes is greater than 100 mm.

7.2.7.2 Full shelves and partitions

The volume of a full shelf or partition shall be the product of its thickness and its depth, width or height, whichever two of these are applicable. The depth, width and height shall be those dimensions of the enclosed space of the cabinet which apply in the plane of the shelf or partition.

7.2.7.3 Fractional shelves and partitions (if applicable)

The volume of a fractional shelf or partition shall be the product of its thickness and its depth, width or height, whichever two of these are applicable.

The depth, width or height shall be the distances from the adjacent surfaces of the enclosed space of the cabinet, and normal to those surfaces, to the further edges of the shelf or partition, or to the evaporator in cases where the fractional shelf or partition touches it, if applicable.

A horizontal shelf or partition, the edges of which are more than 70 mm from the surfaces of the enclosed space of the cabinet, shall be regarded as a fractional shelf or partition. A vertical partition, the edges of which are more than 100 mm from the surfaces of the enclosed space of the cabinet, shall be regarded as a fractional partition.

7.3 Determination of storage shelf area

The area shall be expressed in square decimetres.

7.3.1 Determination of the area of shelves

7.3.1.1 Full shelves composed of a single part

In the case of a full shelf composed of a single part, the area shall be the product of the width and depth. These two dimensions shall be determined as follows.

— Width: mean distance measured parallel to the surface of the shelf between the inner surfaces of the side walls of the enclosed space of the cabinet, where this dimension does not exceed the actual width of the shelf by more than 20 mm [see figure 14 a)].

— Depth: mean distance measured parallel to the surface of the shelf (or of the bottom of the appliance) between the inner surfaces of the front and rear walls of the enclosed space of the cabinet, where this dimension does not exceed the actual depth of the shelf by more than 20 mm [see figure 14 b)]. When the door of an upright-type appliance is provided with shelves, this distance shall be determined by analogy [see figures 14 c) and 14 d)].

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7.3.1.2 Fractional shelves

For the purpose of calculating the area of fractional shelves, the width and depth shall be measured parallel to the surface of the shelves in a similar way to that for full shelves (see 7.3.1.1), but taking into account figure 14 e).

7.3.1.3 Cut-away shelves

When a shelf is cut away, the area of the portion cut out shall be deducted.

7.3.1.4 Juxtaposed shelves

In the case of juxtaposed shelves, the depth shall be determined in accordance with figure 14 d).

7.3.1.5 Door shelves

The area shall be the product of the width and depth. These two dimensions shall be determined by analogy with 7.3.1.1, as follows.

— Width: mean distance between the inner surfaces of the side walls of the door compartment or between the side edges of the retainer bar.

— Depth: mean distance between the surface of the door wall and the vertical plane tangential to the inner front surface of the shelf or retainer bar [see figure 14 c)].

7.3.1.6 Baskets and containers

The area shall be the product of the two mean horizontal dimensions [see figure 15 a)].

7.3.1.7 Particular cases

7.3.1.7.1 General

The bottom of the enclosed space of the cabinet shall be considered as a shelf.

When an inner wall is not vertical, the dimension of the shelf shall be measured at the mid-height between the shelf under consideration and the shelf or horizontal surface immediately above.

7.3.1.7.2 Fresh food storage compartment and cellar compartment, if any

Any part of full shelves, baskets or of the bottom of a compartment having less than 100 mm vertical clearance above, when all the shelves and baskets are in position, shall be excluded when calculating the storage area. However, it is admissible that for one full shelf or basket the vertical clearance may be reduced to not less than 80 mm [see figure 15 b)].

7.3.1.7.3 Food freezer compartments (or cabinets) and low-temperature compartments (or cabinets)

Any part of full shelves, baskets or of the bottom of a food freezer compartment (or cabinet) or frozen food storage compartment (or cabinet) having less than 52 mm vertical clearance above, when all the shelves and baskets are in position, shall be excluded when calculating the storage area [see figure 15 b)].

In the case of an ice-making compartment, the minimum vertical clearance shall not be less than 40 mm.

7.3.2 Drip tray

The drip tray shall not be considered as a food shelf area.

7.3.3 Suspended containers

7.3.3.1 Fresh food storage compartment and cellar compartment, if any

The area of the interior surface of the bottom of a suspended container and the area of the shelf immediately below shall not both be counted unless the vertical clearance between this shelf and the exterior surface of the bottom of the container is at least 100 mm.

Nevertheless, in the case of one container (and one only), this minimum clearance may be reduced to 80 mm to the extent where this possibility has not been applied for the shelves.

If the minimum vertical clearance within a suspended container, as measured between the interior surface of the bottom and the cover, or to the shelf immediately above, is less than 40 mm, the bottom area of the container shall not be added.

7.3.3.2 Food freezer compartments (or cabinets) and low-temperature compartments (or cabinets)

For a food freezer compartment (or cabinet) or frozen food storage compartment (or cabinet), the dimension of the minimum vertical clearances specified in 7.3.3.1 is 52 mm in all cases.

For an ice-making compartment, the minimum vertical clearance dimension is 40 mm in all cases.

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