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Ice-cream freezers — Classification, requirements and test conditions

Congélateurs pour crèmes glacées — Classification, exigences et conditions d'essai

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Contents

Page

Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 7, *Testing and rating of commercial refrigerated display cabinets*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 44, *Commercial and professional refrigerating appliances and systems, performance and energy consumption*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Ice-cream freezers — Classification, requirements and test conditions

1 Scope

This document specifies the classification for horizontal closed ice-cream freezer with access of the product from the top via transparent or solid lid(s) and specifies their requirements and test methods.

The ice-cream freezers defined in this document are different from supermarket segment freezers, as they work with static air cooling, with a skin evaporator (no evaporator fan) and are used specifically for the storage and display of pre-packed ice-cream.

This document is only applicable to integral type refrigeration systems. It is not applicable to remote and secondary system type cabinets. Ice-cream freezers defined in this document are intended to have a net volume ≤600 l. For transparent lid ice-cream freezers only, they are intended to have a net volume/TDA ≥ 0,35 m.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 817, *Refrigerants — Designation and safety classification*

ISO 5149-2, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 2: Design, construction, testing, marking and documentation*

EN 60335-1, *Household and similar electrical appliances — Safety — Part 1: General requirements (IEC 60335-1)*

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1 General

3.1.1
ice-cream freezer
horizontal closed refrigerated cabinet intended to store and/or display and sell pre-packed ice cream where access by the consumer to the pre-packed ice cream is gained by opening a lid (solid or transparent) from the top

Note 1 to entry: See Annex A for the designation of the ice-cream freezer family.

3.2 Parts of ice-cream freezers

3.2.1
condensing unit
combination of one or more compressors, condensers and liquid receivers (when required) and the regularly furnished accessories

3.2.2
night cover
top cover permanently integrated into the *ice-cream freezer* (3.1.1) used to reduce the heat ingress (e.g. by infrared radiation or convection) during the period when there are no sales

3.3 Physical aspects and dimensions

3.3.1
depth
horizontal distance between the front and the rear of the *ice-cream freezer* (3.1.1)

3.3.2
width
horizontal distance between the two external sides of the *ice-cream freezer* (3.1.1)

3.3.3
height
vertical distance from the bottom to the top of the *ice-cream freezer* (3.1.1)

3.3.4
load limit
boundary surface consisting of a plane or several planes within which all *M-packages* (3.5.1) can be maintained within the limits for the declared M-package temperature class

3.3.5
load limit line
permanently marked boundary line denoting the edge of the *load limit* (3.3.4) surface

3.3.6
net volume
V_N
storage volume inside the appliance which can be used for storage of products

Note 1 to entry: The calculation method in 6.2.5 shall be applied.

3.3.7
gross volume
volume within the inside walls of the *ice-cream freezer* (3.1.1) or compartment, including internal fittings and the lid when closed

3.3.8
equivalent volume
V_{eq}
reference volume corrected for compartment temperature classification

Note 1 to entry: The calculation method in Annex B shall be applied.

3.3.9
total display area
TDA
total visible foodstuffs area, including visible area through the glazing, defined by the sum of horizontal and vertical projected surface areas of the *net volume* (3.3.6)

Note 1 to entry: For the calculation method see Annex C.

3.3.10
footprint
surface occupied by the *ice-cream freezer* (3.1.1)

3.4 Performance characteristics

3.4.1
normal conditions of use
operating conditions which exist when the *ice-cream freezer* (3.1.1), including all permanently located accessories, has been set up and situated in accordance with the recommendations of the manufacturer and is in service

Note 1 to entry: The effects of actions by non-technical personnel for the purposes of, e.g. loading, unloading, cleaning, defrosting, the manipulation of accessible controls and of any removable accessories, according to the manufacturer's instructions are applicable within this definition. The effects of actions resulting from interventions by technical personnel for the purposes of maintenance or repair are outside this definition.

3.4.2
defrost
removal of frost, snow and ice from an *ice-cream freezer* (3.1.1)

3.4.3
total energy consumption
TEC
total amount of energy used by an *ice-cream freezer* (3.1.1)

3.4.4
specific energy consumption for ice-cream freezers
SEC
index of the efficiency of the *ice-cream freezer* (3.1.1), expressed as the ratio of TEC divided by *equivalent volume* (3.3.8) (TEC/Equivalent volume)

3.4.5
product temperature
one of the classifications document establishing the performance level of the *ice-cream freezer* (3.1.1)

Note 1 to entry: Defined in Table 1.

3.4.6
relative compressor running time
ratio of compressor running time to overall duration of a measurement cycle excluding defrost time

3.5 Test environment

3.5.1
M-package
test package fitted with a temperature measuring device

3.5.2
climate class
classification of the test room climate according to the dry bulb temperature and relative humidity

3.5.3
M-package temperature class
classification of *M-package* (3.5.1) temperature according to the temperatures of the warmest M-packages during the temperature test

3.5.4
ice-cream freezer classification
designation given by the combination of *climate class* (3.5.2) and *M-package temperature class* (3.5.3)

4 Symbols and abbreviated terms

t_{run} running time — time during which the compressor is running within the 24 h test period

t_{stop} stopping time — time during which the compressor is not running within the 24 h test period and excluding defrost time

Δt time between two consecutive measurement samples

N_{max} number of measuring samples in the 24 h test period

RH Relative humidity

SEC specific energy consumption for ice-cream freezers expressed in kilowatt hours per 24 h per m^3 (TEC/V_{eq});

TEC total energy consumption in kilowatt hours per 24 h period

T_{rr} relative or percentage running time:

$$t_{rr} = \frac{t_{run}}{t_{run} + t_{stop}} \quad (1)$$

where $t_{run} + t_{stop} = 24$ h

t_{90} time in which 90 % of a sudden temperature change of 20 °C is indicated, the measurement medium being moderately agitated air (velocity 1 m/s)

V_{eq} equivalent volume

V_N net volume

5 Classification and requirements

5.1 Classification

The classification of the ice-cream freezers is done according to temperature. The performance of ice-cream freezers shall comply with one of the classifications defined in Table 1. The performance shall be verified in accordance with the conditions and test methods specified in Annex E.

Table 1 — Classification according to temperature

Class	Warmest M-package temperature colder or equal to in all tests except lid opening test °C	Warmest M-package maximum temperature rise allowed K
C1	−18,0	2,0
C2	−7,0	2,0
S	Special classification	2,0

5.2 Requirements

5.2.1 Construction

5.2.1.1 Strength and rigidity

The ice-cream freezer and its parts shall be constructed with adequate strength and rigidity for normal conditions of handling, transport and use. Attention shall be given to the following:

a) interior fittings shall be sufficiently strong for the duty required;

b) where sliding shelves, baskets or trays are fitted they shall retain their shape and ease of movement when fully loaded;

c) any fitments which are provided with stops to prevent accidental removal shall be self-supporting when fully loaded and withdrawn to the limit of the stops.

5.2.1.2 Pipes and connections

Pipes and connections to moving or resiliently mounted parts shall be arranged so as not to foul or transmit harmful vibrations to other parts. All other pipes and connections shall be securely anchored and have sufficient free length and/or vibration eliminators to prevent failure due to fatigue. Where necessary, pipes and valves shall be adequately thermally insulated.

5.2.1.3 Lids

Lids shall be condensate-free at the climate class specified by the manufacturer.

When any lids provided to ensure an air seal to the refrigerated space are closed, there shall be no undue leakage of ambient air into the interior (see 6.2.1). The lids shall not open of their own accord.

The gasket shall be made from a material whose characteristics are compatible with the operating conditions (especially temperatures). If the fastening device is mechanical, a stop or other means shall be provided to prevent the gasket from being excessively deformed.

5.2.1.4 Joints and seams

All construction joints and seams within the net volume shall prevent the accumulation of potentially contaminating substances. All construction joints and seams within the net volume shall permit the easy removal of any deposits of potentially contaminating substances.

5.2.2 Materials

5.2.2.1 General

The materials shall be durable and shall not favour the development of mould or emit odours. Under normal conditions of use, materials in contact with foodstuffs shall be resistant to moisture and shall neither be toxic nor contaminate them.

5.2.2.2 Corrosion resistance

Metal parts, used in the construction of cabinets, shall have resistance to corrosion appropriate to their location and function.

5.2.2.3 Thermal insulation

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

Suitable means shall be used to prevent deterioration of the thermal insulation by the ingress of moisture.

Where the insulation space is vented to the inside, it shall be ensured that particles of the insulation material cannot escape into the foodstuff display compartment.

For fibrous insulation materials, it shall not be possible to insert a rigid probe of 1 mm diameter through any aperture which allows access to the insulating material, the probe being applied with negligible force.

5.2.3 Refrigerating system

5.2.3.1 Design and construction

The design and construction of all parts of the refrigerating system subject to internal pressure shall take into account the maximum working pressure to which they are subjected when the ice cream freezer is in operation or at rest. The maximum ambient temperature during transit shall be taken into account. All refrigerant containing components shall be in accordance with ISO 5149-2.

5.2.3.2 Condensation

There shall be suitable means to prevent water condensing on cold surfaces of the ice cream freezer and its parts and from harmfully affecting the operation of the refrigerating system or its controls.

5.2.3.3 System protection

For ice-cream freezers, the refrigerating system shall suffer no damage if any lid in the cooler is left open while the ice cream freezer is operating in an ambient temperature corresponding to the climate class (see Table 1) for which the cooler is intended. When the lid is kept open under normal operating conditions (for example, during product loading) or is left open accidentally, any automatic motor overload protective device may come into operation.

5.2.3.4 Refrigerant

When deciding on the refrigerant for the system, attention shall be given to the possible hazards associated with the use of certain refrigerants and heat-transfer media due to their toxicity, flammability, etc. Guidance on this point is available in ISO 5149-2.

5.2.4 Electrical components

5.2.4.1 General

Electrical components shall be in accordance with EN 60335-1 and EN 60335-2-89.

5.2.4.2 Temperature display

The ice-cream freezer shall incorporate a temperature display instrument showing the air temperature in the refrigerated display ice-cream freezer, at the load line, to provide an indication of the operation and functioning of the refrigerating equipment and information on its operating state.

NOTE As a rule, measured air temperature is not identical with pre-packed ice-cream temperature in an ice-cream freezer.

5.2.4.3 Temperature-measuring instrument

Suitable temperature-measuring instruments shall be used, i.e. those that fulfill the following requirements:

— the unit symbol (°C) shall be inscribed or displayed on the temperature-measuring instrument;

— the range of measurement shall be at least from −40 °C to + 40 °C;

— the scale division or smallest numerical increment shall be less than or equal to 1 °C;

— the maximum errors shall be 2 K over the total measuring range;

— the time constant t_{90} of the sensor shall be equal to or less than 20 min.

When temperature-measuring instruments are employed in ice-cream freezers:

— one temperature-measuring instrument shall be employed for each ice-cream freezer with its own refrigerating circuit.

5.2.4.4 Temperature sensor location

The temperature sensor location shall be readily accessible to enable on-site testing for the correct indication of temperature and replacement of the temperature measuring instrument on-site in service.

The temperature sensor of a thermometer is considered to be "readily accessible" if it is reached directly for examination. It is necessary to remove the access panel(s) to carry out replacement.

NOTE 1 The positioning of the temperature sensor in a guide tube is also considered to be "readily accessible" if the sensor is introduced into and removed from the guide tube without a tool.

Wherever possible, the mounting method shall not supply heat to, or withdraw heat from the temperature sensor. The temperature sensor shall be protected against heat radiation from the external ambient.

NOTE 2 For electronic controllers, it is possible to display a calculated temperature.

NOTE 3 For recording and display of temperatures, one or two temperature sensors are used. The temperature sensor is the same as those used for controlling the refrigeration. An alarm is activated in case of error. This option is not in accordance with the requirements of EN 12830.

5.2.5 Operating characteristics

5.2.5.1 Water vapour condensation

The performance of the ice-cream freezer shall not be impaired by water vapour condensation. The amount of water vapour condensation shall be verified according to the conditions and test methods specified in 6.3.6.4.

5.2.5.2 Energy consumption

The energy consumption shall be stated by the manufacturer. The total energy consumption (TEC) shall be measured and calculated according to the conditions and the test methods specified in 6.3.6.6.3.

5.2.5.3 Specific energy consumption

The ice-cream freezer specific energy consumption (SEC) as ratio between TEC and equivalent volume (TEC/V_{eq}) shall be stated by the manufacturer. This value shall be used to compare the energy efficiency between different ice-cream freezers.

6 Tests

6.1 General

When the characteristics of an ice-cream freezer are to be verified, all the tests and inspections shall be applied to one and the same ice-cream freezer. These tests and inspections may also be made individually for the study of a particular characteristic.

Table 2 lists the tests and inspections that shall be carried out. Ice-cream freezers shall comply with the requirements specified in this part of the document using the appropriate test method.

Table 2 — Test summary

Tests and inspections	Requirement clause	Test method	Test room
Seal test	5.2.1.3	6.2.1	Outside test room (see 6.2)
Absence of odour and taste (not compulsory)	—	Annex D	
Durability of lid	5.2.1.3	6.2.2	
Temperature	5.1	6.3.6.1	Inside test room (see 6.3)
Water vapour condensation	5.2.3.2	6.3.6.4	
Temperature rise time	—	6.3.6.5	
Energy consumption	5.2.5.2	6.3.6.6	

6.2 Tests outside test room

6.2.1 General

The tests which may be carried out outside the test room deal with the inspection of construction characteristics, physical dimensions and the absence of odour and taste.

6.2.2 Seal test for lids

The effectiveness of lids provided to ensure a seal shall be tested as follows (with the ice-cream freezer not running). Insert a strip of paper 50 mm wide, 0,08 mm thick and of a suitable length at any point of the seal. With the lid closed normally on it the strip of paper shall not slide freely.

NOTE 1 Attention is drawn to the fact that some ice-cream freezers having lids are fitted with decompression valves which allow air to penetrate for a short period of time so that any drop in pressure created inside the ice-cream freezer is compensated. No test is required for such valves.

NOTE 2 The most unfavourable points can be found by inspecting the contact of the seal with the ice cream freezer closed and lighted from the inside.

6.2.3 Test on durability of lid

6.2.3.1 General

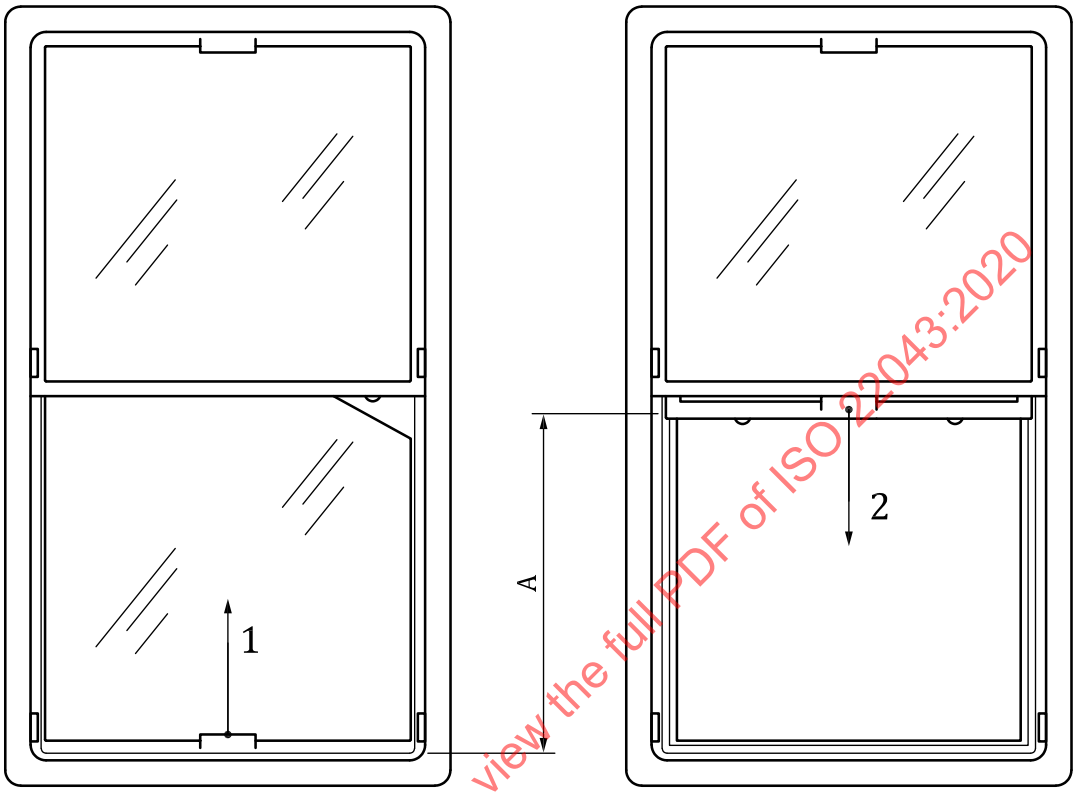
The purpose of these tests, carried out using the following procedures, is to check the durability of the lids. The ambient temperature shall be between +16 °C and +32 °C. The refrigerating appliance shall be switched off.

6.2.3.2 Opening sequence

The lids shall be pulled out to within 15 mm to 20 mm of their fully open position (Figure 1).

6.2.3.3 Closing sequence

The lids shall be closed as in normal use from within 15 mm to 20 mm of their fully closed position (Figure 1).



Key

A opening course
1 pull out
2 push

Figure 1 — Durability of lid

The number of cycles per minute shall be between 5 and 10. Each lid shall withstand 30 000 opening and closing operations without deterioration which could be prejudicial to the air-tightness of the lid sealing. All the lids shall be present on the cabinet when tested.

6.2.4 Linear dimensions, areas and volumes

Measurements shall be made with the ice-cream freezer not in operation but situated in a place where the temperature is maintained between 16 °C and 30 °C. If the ice cream freezer includes jacks or other components for adjustment of height (i.e. castor or wheel), the height defined shall be the minimum height necessary at installation of the ice cream freezer.

When measuring the net volume, parts necessary for the proper functioning of the ice-cream freezer shall be fitted as intended and the volume representing the space occupied by these parts deducted (see 6.2.5).

6.2.5 Net volume calculation

The net volume (VN) shall be calculated as the sum of the individual volumes obtained within the load limit lines, excluding any basket(s).

Each of the individual volumes shall be expressed in litres, to two decimal places. The net volume shall be rounded to the nearest decimal place.

6.3 Tests inside test room

6.3.1 General

The tests which are carried out inside the test room measure the following characteristics:

— temperature;

— water vapour condensation;

— electrical energy consumption.

General test conditions are defined, which are common for all tests carried out inside the test room. These conditions concern the test room, the test and M-packages, and the measuring instruments.

6.3.2 Test room conditions

6.3.2.1 Design, walls, floor and radiant heat

The test room shall be a parallelepiped space in which two of the opposite side walls, referred to as the discharge technical side wall and the return technical side wall, are designed to create an even, horizontal air flow within the test room. By convention, the distance separating these two technical side walls is referred to as the "length" of the test room.

The minimum useful dimensions (length, width, height) of the test room shall be dependent on the overall dimensions (length, depth, height) of the ice-cream freezer to be tested.

The ceiling and the two non-technical side walls of the room shall be thermally insulated and shall be equipped with an inner metal skin.

A minimum insulation level equivalent to 60 mm of rigid polyurethane foam (λ = 0,03 W/m °C) should be used for the building of a new test room.

The floor shall be made of concrete or of thermally equivalent material and/or shall be sufficiently insulated to ensure that external climatic conditions do not affect the floor temperature.

Lighting shall be installed to maintain (600 ± 100) lx measured at a height of 1 m above the floor level and shall be lit continuously during the test period. The emission spectrum of that lighting device within the infrared field shall not include peaks of a value of more than 500 W/5 nm/lm.

The walls, ceilings and any partitions of rooms intended for the testing of the ice-cream freezer shall be painted in light grey (for example, NCS 2706-G90Y or RAL 7032) with an emissivity between 0,9 and 1 at 25 °C.

6.3.2.2 Thermal and air flow characteristics

An experimental evaluation of the test-room performances shall be carried out at a minimum of once per year

— with test room empty and with lighting switched on,

— in a test room at ambient temperature of 25 °C and 60 % RH,

— measuring the velocity, temperature and relative humidity of the air at different points within two vertical planes parallel to the technical side walls and 600 mm away from the technical side walls, and

— with the climate measuring point located at the geometrical centre of the test room during the evaluation.

These measuring points shall form a two-dimensional grid in which the step is a maximum of 500 mm in the horizontal and vertical directions. The peripheral line of points shall be located at a maximum of 500 mm from the other two side walls, floor and ceiling.

A three-dimensional grid inside the test room shall be investigated when obstacles/irregularities projected into the room of more than 1 m^2 surface area facing the discharge technical side wall exist along the walls.

The mean horizontal air velocity measured during 1 min with a maximal interval of 5 s at each of the points defined above shall lie between 0,1 m/s and 0,2 m/s.

Air temperature measured at each of the points defined above shall not deviate from the rated temperature of the test-room climate class by more than 2 °C.

The test room shall be capable of maintaining values of humidity within ±5 units of the relative humidity percentage figures of the rated humidity of the test room temperature class at the specified measuring points.

Surface temperature of walls, ceiling and floor shall be measured in proximity to the points which constitute the peripheral line of the grid defined above. These surface temperatures shall remain within a tolerance of ±2 °C in relation to the air temperature measured at the nearest point of the grid.

6.3.2.3 Climate classes

Tests shall be carried out in one of the climate classes according to Table 3.

During the test, the test room shall be capable of maintaining values of temperature and humidity within ±1 °C of the temperature and ±5 units of the relative humidity percentage figures at the specified climate measuring point(s) (see 6.3.5.3).

Table 3 — Test room climate classes

Test room climate class range	Minimum temperature and relative humidity	Maximum temperature and relative humidity
A	+16 °C, 80 %	30 °C, 55 %
B	+16 °C, 80 %	35 °C, 75 %
C	+16 °C, 80 %	40 °C, 40 %

6.3.3 Test packages and life-time

6.3.3.1 General

When tests are carried out, test packages in the form of rigid parallelepipeds shall be used; the size and mass of the test packages, including their packaging, shall be as specified in Table 4.

The tolerances for new test packages shall be:

— ±2 mm for linear dimensions 25 mm to 50 mm,

— ±4 mm for linear dimensions 100 mm to 200 mm, and

— ±2 % for mass.

Table 4 — Dimensions and mass of test packages

Dimensions mm	Mass g
50 × 100 × 100	500

Table 4 *(continued)*

Dimensions mm	Mass g
50 × 100 × 200	1 000
The following packages may be used as fillers to complete the cabinet loading: 25 × 100 × 200	500

Due to the frequency of use and to the loading pressure, the packages could change in dimensions and weight. Test packages shall be checked annually for conformity with the following life-time tolerances. When a test package is found to exceed one of the following tolerances, it shall be replaced:

a) Loss of mass: −5 %.

b) On the wrapper: visible hole.

c) Change in linear dimensions:

   1) ±4 mm for dimensions 25 mm and 50 mm;

   2) ±8 mm for dimensions 100 mm and 200 mm.

Each test package shall consist of a filling material and a wrapper.

Filling material containing, per 1 000 g:

— 230,0 g of oxyethylmethylcellulose,

— 764,2 g of water,

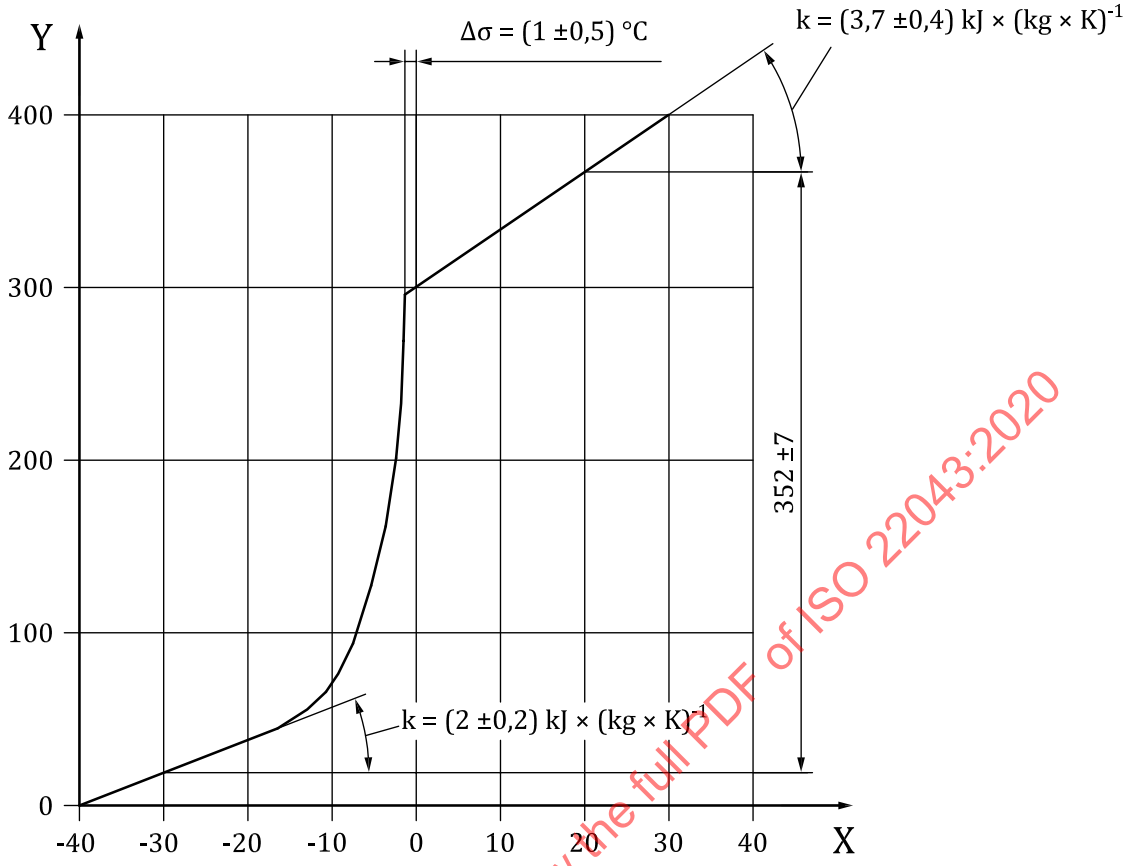
— 5,0 g of sodium chloride, and

— 0,8 g of para-chlorometa-cresol.

The freezing point of this material is −1 °C (its thermal characteristics corresponding to those of lean beef). The enthalpy value of 285 kJ/kg shall correspond to the temperature (−1 ± 0,5) °C (see Figure 2, Tables 5 and 6).

About 4 % of water should be added in order to compensate for evaporation during the preparation of the filling material.

Wrapper: a sheet of transparent colourless plastic or any other suitable material of such nature that exchange of moisture with the ambient medium is negligible being the surface emissivity coefficient equal to or greater than 0,9 at 25 °C. The maximum total thickness shall be 1,0 mm. After filling this sheet shall be sealed.



Key

X temperature, °C

Y specific enthalpy, kJ/kg

Figure 2 — Thermal characteristics of test packages

Table 5 — Temperature and specific enthalpy of test packages

Temperature °C	**Specific enthalpy** kJ/kg
−40	0
−30	19
−25	28
−20	39
−18	43
−16	49
−14	55
−12	63
−10	73
−9	79
−8	85
−7	93
−6	102
−5	114
−4	129

Table 5 *(continued)*

Temperature °C	Specific enthalpy kJ/kg
−3	152
−2	194
−1	285
0	297
+10	334
+20	371

Table 6 — Temperature and increase in specific enthalpy of test packages

Temperature range °C	Increase in specific enthalpy kJ/kg
−30 to −20	20 ± 2
+10 to +20	37 ± 4
−30 to +20	352 ± 7

6.3.3.2 M-packages and life-time

Some of the 500 g packages (50 mm × 100 mm × 100 mm) specified in Table 4 shall be equipped for temperature measurement, being fitted with temperature sensor inserted in the geometrical centre of the packages in direct contact with the filling material. All precautions shall be taken to minimize extraneous conduction of heat and to avoid any possibility of entrance of the air from the hole in the wrapper for the passage of the temperature sensor that could create oxidation and loss of weight in the filling material. These packages are called M-packages (see Figure 3).

Due to frequency of use and loading pressure the package could change in dimensions and weight. All M-packages shall be checked annually for conformity with the life-time tolerances specified in 6.3.3. The checking results shall be recorded for all M-packages. When an M-package is found to exceed one of the tolerances, it shall be replaced.

Dimensions in millimetres

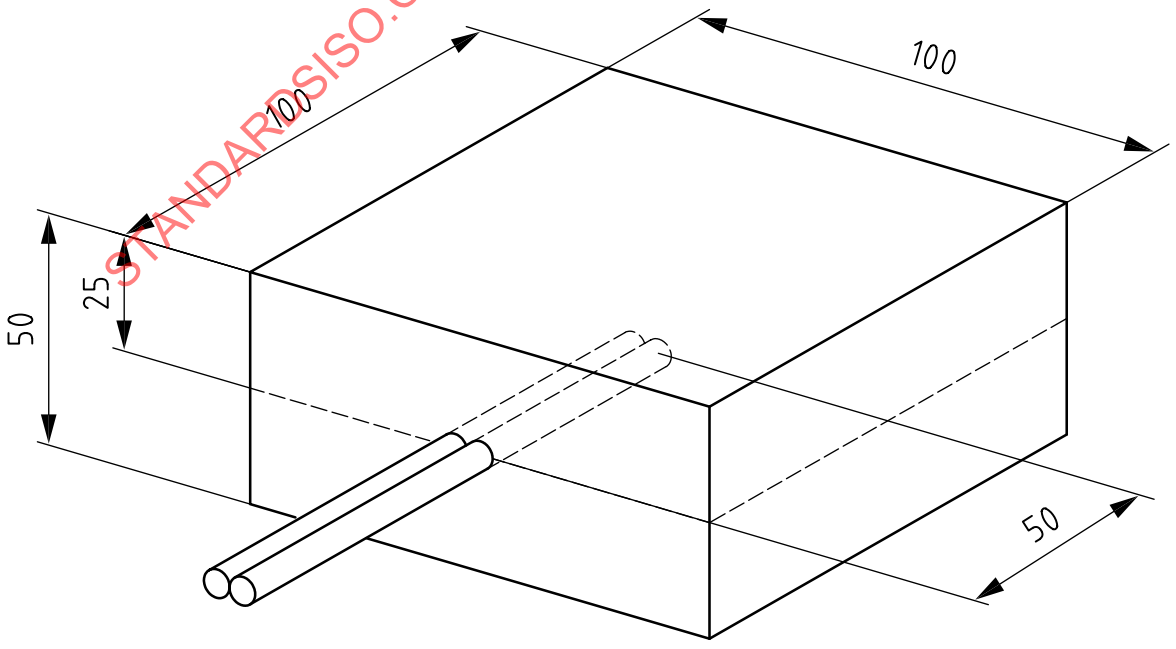


Figure 3 — M-package

6.3.3.3 Alternative for filling test packages

Alternatives for filling test packages having the dimensions shown in Table 4 and density of (480 ± 80) kg/m^3 can be used, except for rows and columns in transverse sections containing M-packages.

This test package may be a box made of plastic material of any density, and of 1 mm nominal thickness. Cellular or foam material shall not be used. The case shall not incorporate any protrusions that would cause the vertical separation of packages in a stack. Opposite faces shall be substantially parallel, and moulding draft shall be the minimum practicable. Seams or joints shall not result in protrusions sufficient to cause significant air gaps between adjacent packages.

Colour can be important if dark enough to be affected by ambient heat radiation; however, a pastel colour, e.g. light pink, pale blue or green, shall have no significant effect in normal surroundings.

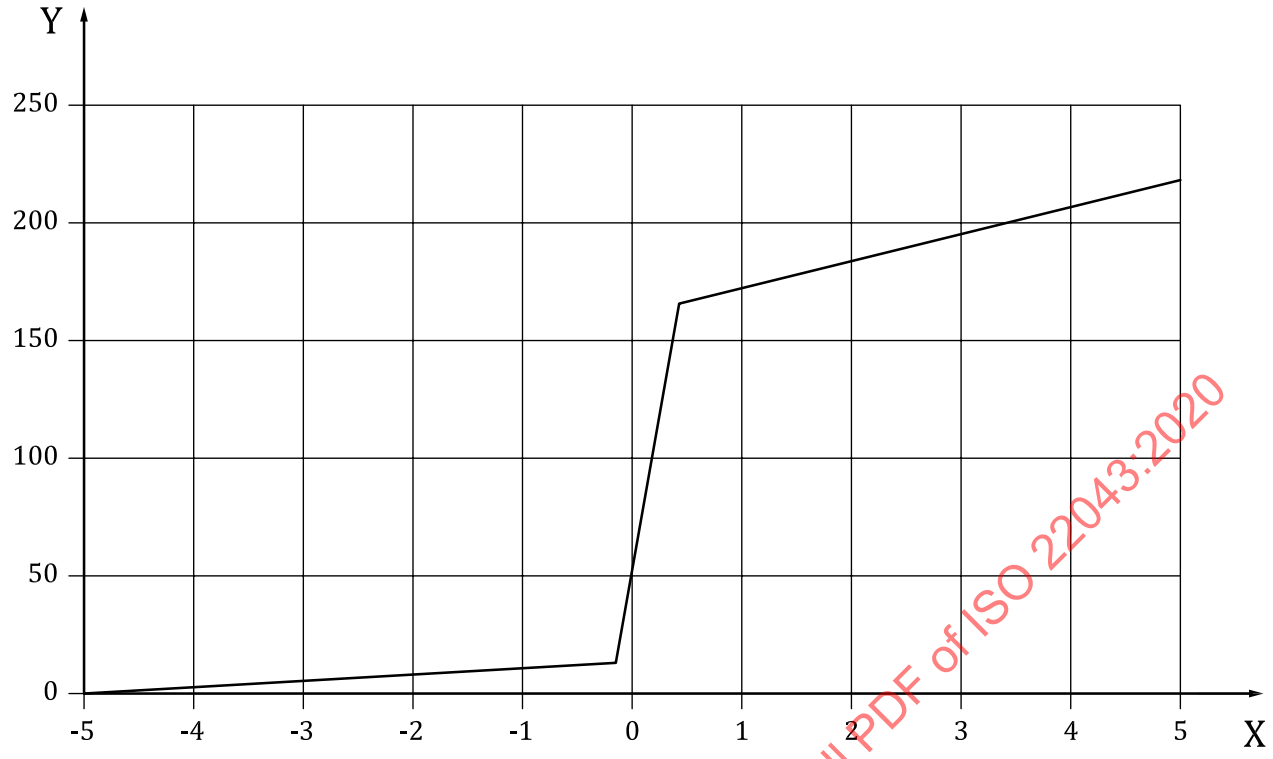
The contents shall be water containing 0,08 % of para-chlorometa-cresol and 0,5 % of sodium chloride, soaked into a porous material such as a natural, plastic or cellulose sponge (see Table 7; Table 8 and Figure 4).

Table 7 — Temperature and specific enthalpy of filler packages

Temperature °C	Specific enthalpy kJ/kg
−5	0
−4	3
−3	4
−2	7
−1	10
0	45
+1	172
+2	183
+3	194
+4	206
+5	218

Table 8 — Temperature and increase in specific enthalpy of filler packages

Temperature range °C	Increase in specific enthalpy kJ/kg
−5 to −1	10
−1 to +1	162
+1 to +5	46
−5 to +5	218



Key

X temperature, °C

Y specific enthalpy, kJ/kg

Figure 4 — Thermal characteristics of filler packages

6.3.4 Instruments, measuring equipment and measuring expanded measurement uncertainty

All measurements shall be carried out with instruments that have been calibrated.

— Temperature measurements shall be made to an expanded measurement uncertainty of ±0,8 °C. Climate temperatures shall be measured by sensors, inserted in the centre of tinned solid copper or copper-zinc alloy cylinders having a mass of 25 g and of minimum external area (diameter = height = approximately 12,5 mm).

— Illumination flux per square metre shall be measured to an expanded measurement uncertainty of ±10 %.

— Relative humidity shall be measured to an expanded measurement uncertainty of ±3 units of the percentage figure.

— Electrical energy consumption shall be measured to an expanded measurement uncertainty of ±2 %.

— Time interval measurements shall be made to an expanded measurement uncertainty of ±1 % or better. All the temperatures shall be recorded at a maximum interval of 60 s. Air velocity shall be measured using a laboratory-type instrument with an expanded measurement uncertainty of 10 % and with a minimum sensitivity of 0,03 m/s in the range of 0 to 1,5 m/s in horizontal flow at the temperature of the selected ambient class.

6.3.5 Preparation of test ice-cream freezer

6.3.5.1 Selection, installation and positioning within the test room

Each ice-cream freezer intended to be tested, unless a prototype, shall be selected from stock or routine production and shall be representative of normal construction and adjustment.

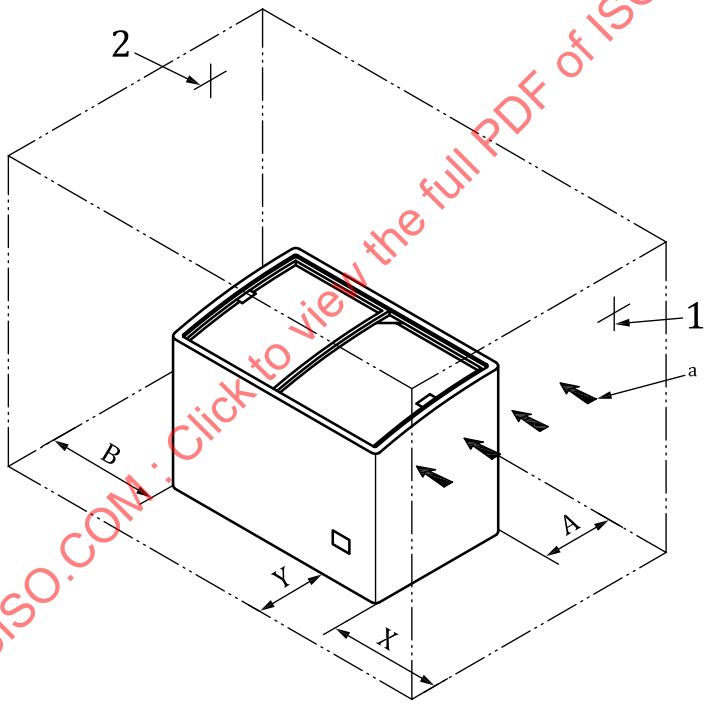
The ice-cream freezer, including all components required for normal operation, shall be assembled, set up and sited as it would be installed in service as far as practicable and in accordance with the manufacturer's instructions. All permanently located accessories required for normal use shall be in their respective places.

The ice-cream freezer shall be located as follows (see Figure 5):

— $X = 2$ m and $B \geq 1$ m for all ice-cream freezers;

— $Y \geq 0{,}8$ m for all ice-cream freezers;

— $A = 0{,}1$ m.



Key

1 technical side wall – test room air discharge

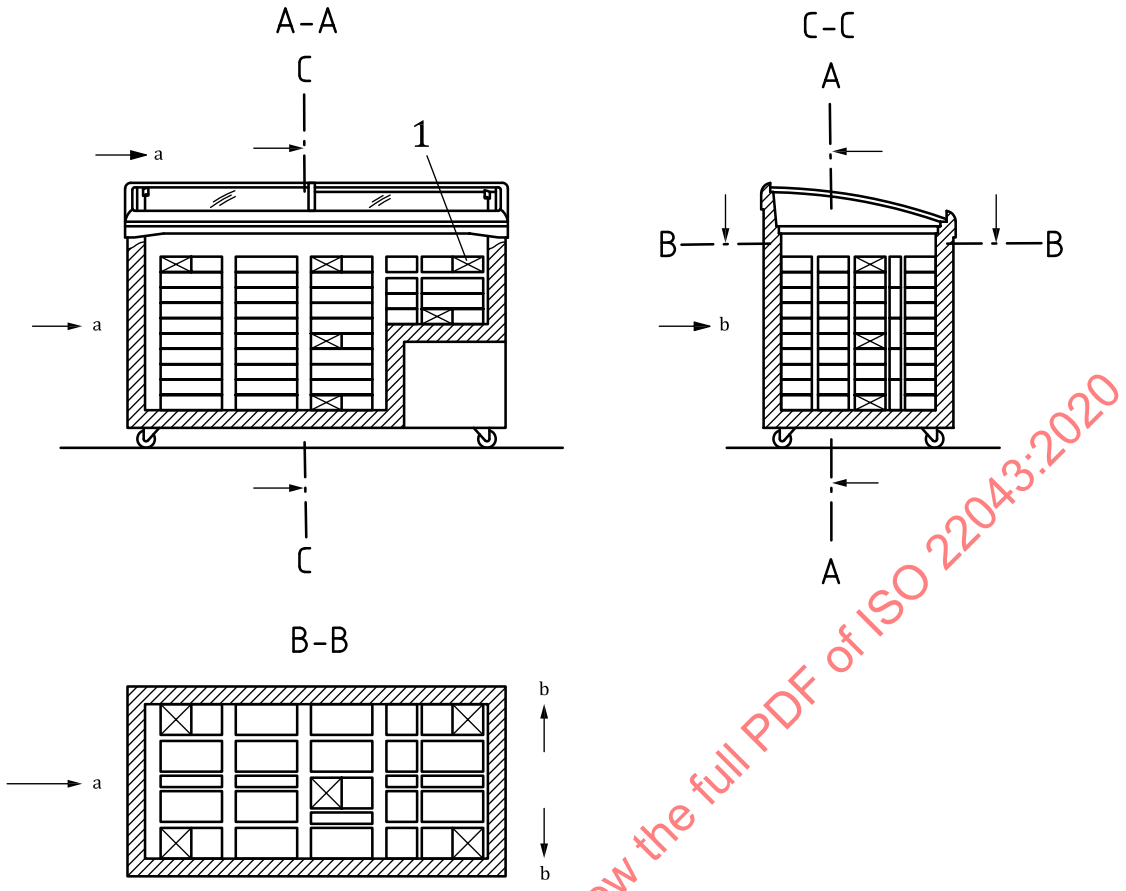
2 technical side wall – rest room air return

A, B, X, Y distance from the technical side wall

[a] Air currents parallel to the plane of the opening surface (in longitudinal direction).

Figure 5 — Ice-cream freezer location within the test room

The direction of the warm condenser airflow should be the same as the test room air flow direction and not opposed to it. If this is not possible because of the cabinet's design the condenser airflow should be perpendicular the test room airflow direction (see Figure 6).



Key

1 M-package

a Air currents parallel to the plane of the opening surface (in longitudinal direction).

b Air flow direction of condensing unit.

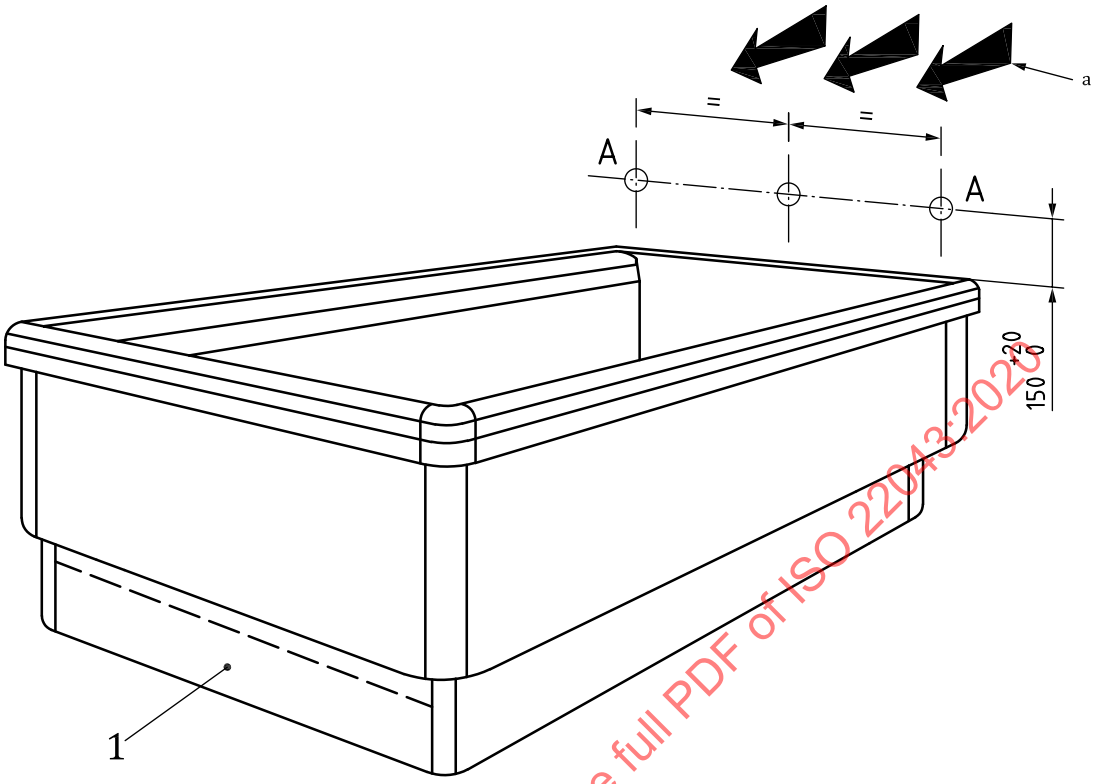
Figure 6 — Condensing air with test room air flow, or across, but not opposed the test room air flow

6.3.5.2 Air movement

Air movement shall be provided. The air movement, shall be, as far as practicable, parallel to the plane of the cabinet display opening and to the longitudinal axis (see Figure 7). The length of the cabinet is defined as the longest horizontal dimension of the display opening. With the refrigerated display cabinet switched off, the air velocity at the three points along the line shown in Figure 7 shall be $0{,}2^{+0}_{-0{,}1}$ m/s. For ice-cream freezers with lids, the direction of air flow shall be such that the air movement is parallel to the plane of the cabinet display opening and the air enters the cabinet when the lid(s) is (are) open.

Test room air movement shall be checked during the test in order to be sure that the test room is running correctly.

Dimensions in millimetres



Key

A-A line for the measurement of the air velocity

1 possible location of condensing unit

[a] Air currents parallel to the plane of the opening surface (in longitudinal direction).

Figure 7 — Air movement

6.3.5.3 Climate measuring point

The point for measurement of ambient temperature and relative humidity shall be midway along the length of the ice-cream freezer and in accordance with Figure 8.

For ice-cream freezers, the warm condenser air flow shall be prevented from influencing the temperature at the measuring point by air deflectors or other suitable means (see Figure 8).

Dimensions in millimetres

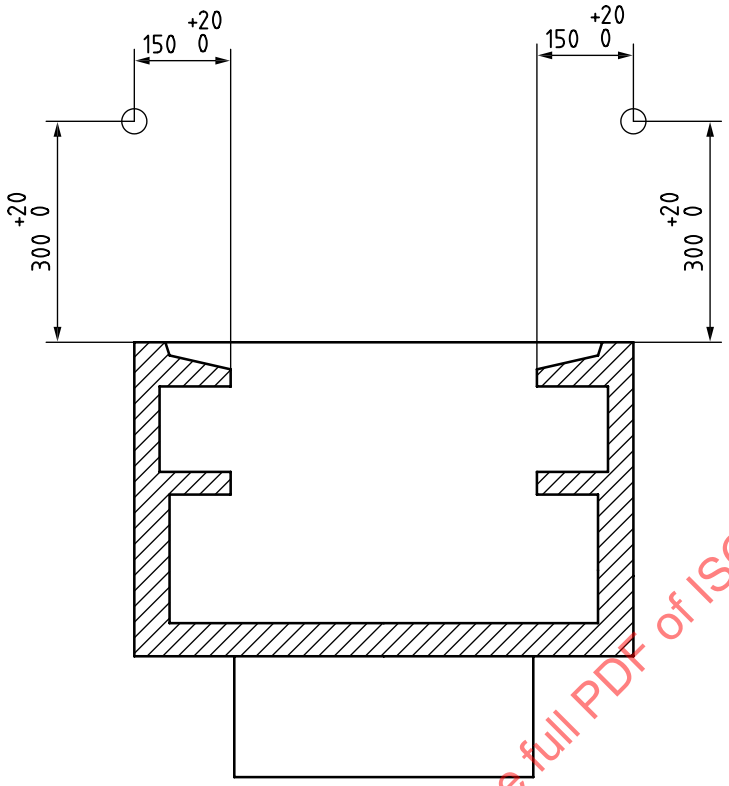


Figure 8 — Climate measuring point for ice-cream freezer

6.3.5.4 Loading the ice-cream freezer

6.3.5.4.1 General

The ice-cream freezer shall be loaded with test packages and M-packages (see 3.5.1) up to the load limit, as illustrated in Figure 9 and Figure 10. These packages shall have been brought previously to a temperature equal to that expected during the test. 1 000 g packages and 500 g packages should be used. To complete the loading, use test packages of the following sizes:

— 25 mm × 100 mm × 200 mm.

The test packages shall be arranged so as to form an even level.

A clearance of 25 mm ± 5 mm shall be left between package rows and adjacent to the internal end walls of the ice-cream freezer.

It is permitted to use partitions with a thickness of approximately 25 mm to position the packages on condition that they have minimal effect on normal airflow and minimal thermal conduction.

Lengthways, rows shall be 200 mm, any remaining spaces shall be filled with test packages to obtain one or two adjustment rows of which the width can measure from 100 mm up to 300 mm.

Depth-wise, any remaining spaces of less than 25 mm wide shall be filled with wooden vertical dividers, placed approximately midway along the space between two M-packages.

Metallic grids (non-conductive material) can be used to support the test package loading on M-package rows and the adjacent ones.

6.3.5.4.2 Loading heights

The loading height of the refrigerated shelves shall be equal to the height defined by the load limit, with a tolerance of $^{+0}_{-25}$ mm (see Figure 9 and Figure 10).

6.3.5.4.3 M-package locations

The M-packages shall be placed at the position shown in Figure 9 and Figure 10.

6.3.5.4.4 Longitudinal section

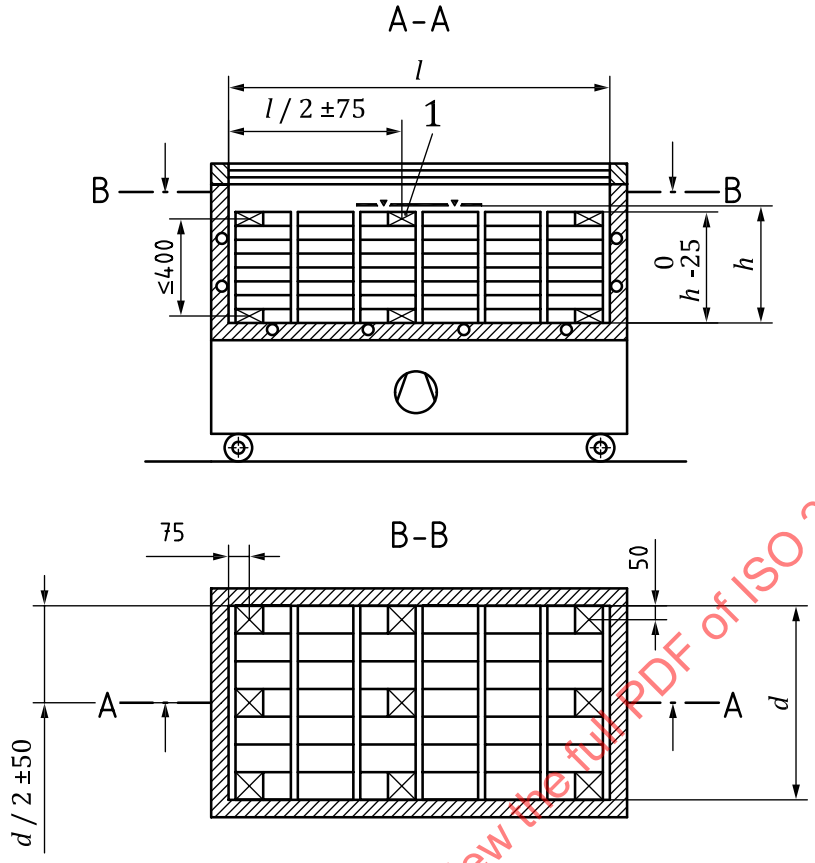
For ice-cream freezer lengths of less than or equal to 700 mm, M-packages shall be located into two transverse sections of the loading such that the M-package axis is situated at 75 mm from each ice-cream freezer end wall.

For ice-cream freezer lengths of more than 700 mm, a third transverse section shall be placed midway along the ice-cream freezer length, with a tolerance of 75 mm. When the ice-cream freezer includes at its central area any mechanical structure, M-packages of this third transverse section and located against the back panel shall be shifted towards the test room air discharge side by 325 mm.

6.3.5.4.5 Cross-section

For refrigerated base deck depths of less than or equal to 550 mm, M-packages shall be located into two longitudinal sections, such that the M-package axis is situated at 50 mm from the back wall and 50 mm from the front wall (see in Figure 9 and Figure 10).

Dimensions in millimetres

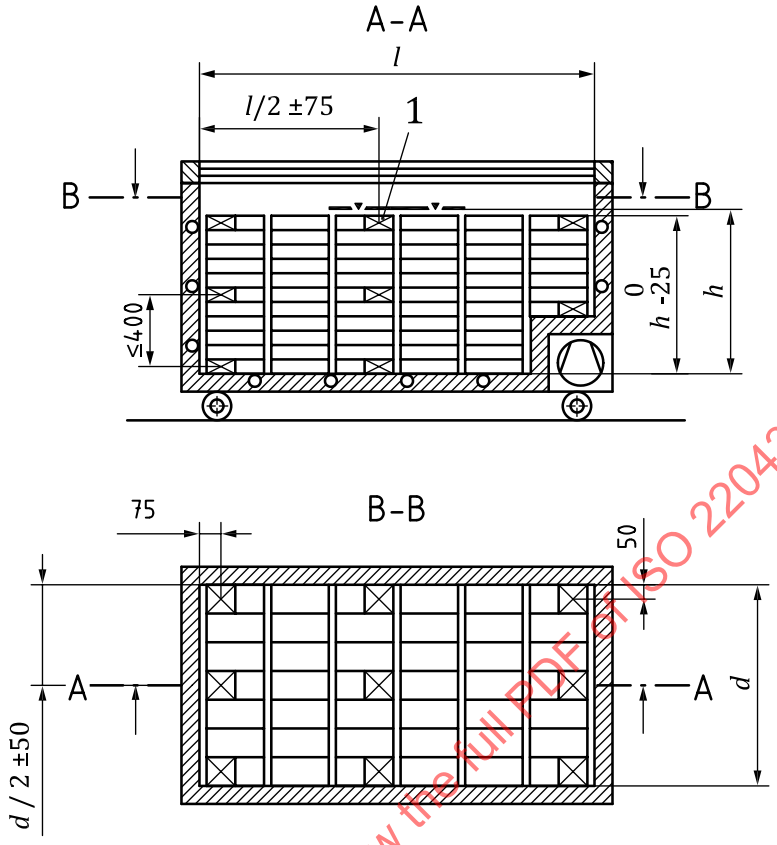


Key

1 M-package
d depth of base deck
h height at load limit
l length of the ice cream

Figure 9 — Glass lid ice-cream freezer with flat base deck with and without tubes laid at the base

Dimensions in millimetres



Key

1 M-package
d depth of base deck
h height at load limit
l length of the ice cream

Figure 10 — Glass lid ice-cream freezer with stepped base deck with and without tubes laid at the base

6.3.5.5 Running in

When an ice-cream freezer is tested, the operating conditions shall comply with those stated by the ice-cream freezer manufacturer.

Adjustable automatic controllers shall be set in such a way that the required M-package temperature class of the ice-cream freezer is reached. Where the controller is not adjustable, the ice-cream freezer shall be tested as delivered.

The manufacturer's recommended routine of defrosting shall be followed. Before tests are started, the ice-cream freezer shall be switched on and allowed to run when empty for at least 12 h at the specified climate class and without erratic functioning of the refrigerating system, controls or defrosting operations. Otherwise, the running-in period shall be continued accordingly.

After the running-in period, the ice-cream freezer shall be filled with test packages and M-packages according to 6.3.5.4.5 for the tests.

After loading, the ice-cream freezer shall be operated until stable conditions have been reached (see 6.3.5.6) and during the test period (see 6.3.5.7). The test room shall be maintained at the desired climate class as specified in 6.3.2.3 while the temperatures of the M-packages are recorded.

6.3.5.6 Stable conditions

An ice-cream freezer is considered to operate under stable conditions if, during a period of 24 h, the temperature of each M-package agrees within ±0,5 °C at the corresponding points on the temperature curve.

Stable conditions shall be determined prior to the door opening sequence and, if the ice-cream freezer is fitted with lighting, the lights shall be continuously left switched on during the stable period. Night covers shall not be in place during the stable running period.

6.3.5.7 Test period

The test period shall be not less than 24 h for all ice-cream freezers, under stable conditions.

6.3.5.8 Lighting and night-covers

Prior to the tests being carried out, the ice-cream freezer shall have been operated for 24 h under stable operating conditions as defined in 6.3.5.6.

Ice-cream freezers shall undergo both the energy consumption test and storage temperature test reported in Figure 11.

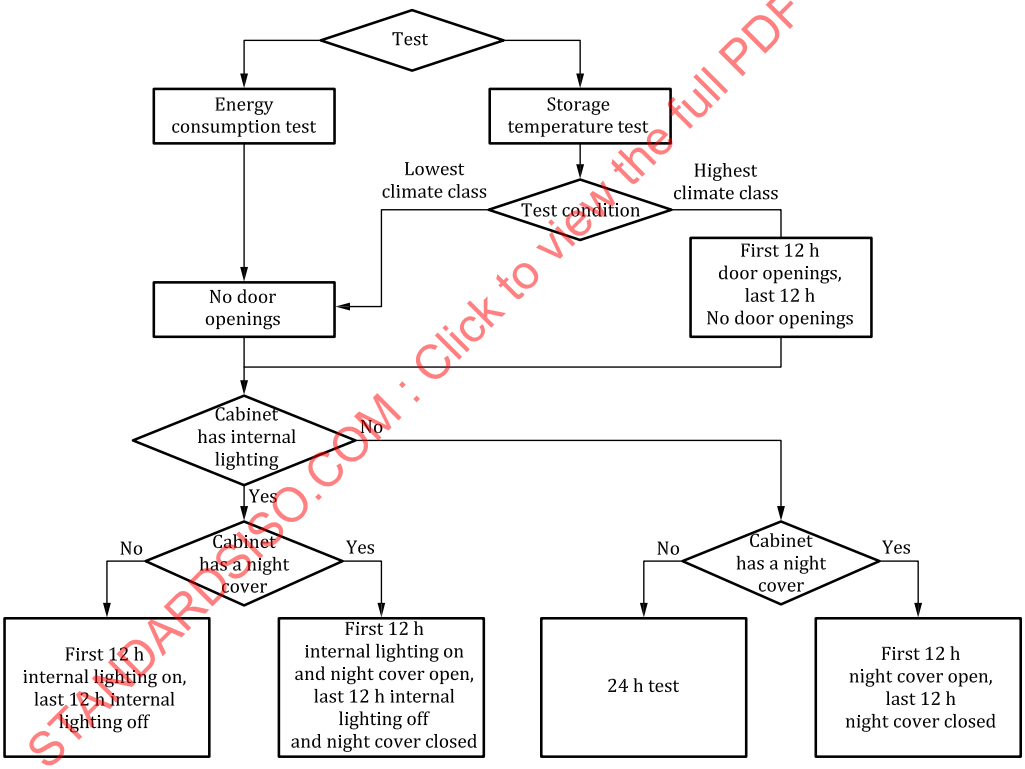


Figure 11 — Tests on ice-cream freezers with lights or without lights

6.3.5.9 Test on several ice-cream freezers in the same test room

If more than one ice-cream freezer in the same room is being tested, appropriate arrangements, such as the use of partitions, shall be made in order to ensure that the conditions surrounding each ice-cream freezer are in accordance with the test requirements specified in 6.3.5.1 and 6.3.5.2.

6.3.6 Test on ice-cream freezers

6.3.6.1 Temperature test

6.3.6.1.1 General

Two temperature tests are carried out to check performance of the ice-cream freezer under the minimum and maximum operating conditions tests a) and b) in 6.3.6.1.2.

A third test is carried out to measure the TEC in 6.3.6.6.2.

6.3.6.1.2 Test conditions

The following test conditions shall be applied:

a) Temperature test for checking the minimum storage temperatures of the ice-cream freezer:

   +16 °C for class A; 80 % RH;

   +16 °C for class B; 80 % RH;

   +16 °C for class C; 80 % RH;

b) Temperature test for checking the maximum storage temperatures for of the ice-cream freezer:

   +30 °C for class A; 55 % RH;

   +35 °C for class B; 75 % RH;

   +40 °C for class C; 40 % RH;

   NOTE For a rated range of climate classes, tests are performed at the extreme ambient temperatures of the range of rated classes.

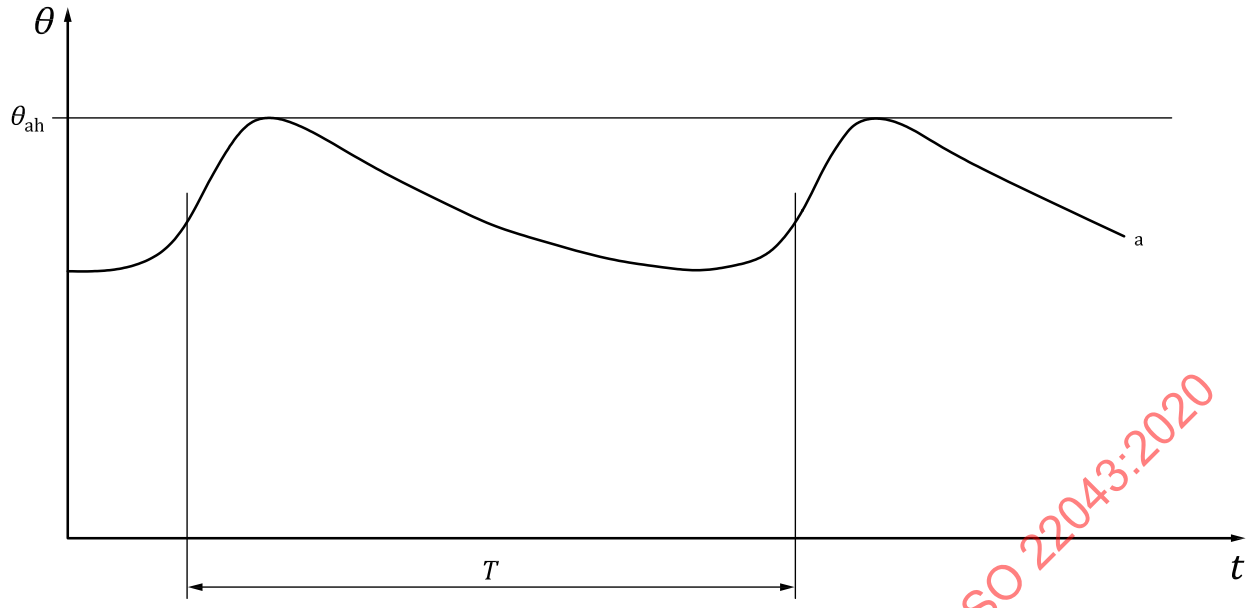
   EXAMPLE For an ice cream freezer rated from A to C, tests are performed at + 16 °C and at + 40 °C.

c) Temperature test for the measure of the total energy consumption:

   +30 °C –55 % RH for classes A, B, C.

6.3.6.1.3 Temperature curves of M-packages

For each temperature test at the test condition described in 6.3.6.1.2 from the recorded temperatures of all M-packages, curves shall be plotted in function of time, related to the temperature of the warmest M- package (i.e. the one with the highest peak temperature θ_{ah}) (see curve a in Figure 12). All other M-package temperatures shall be available for reference if required.



Key

θ temperature
θ_{ah} highest temperature of warmest M-package
t time
T test period
a temperature curve a of warmest M-package

Figure 12 — Relevant temperature curve of M-packages

6.3.6.1.4 Calculation of average mean temperature

The average instant temperature at measuring sample n of all M-packages, θ_{cn} (curve c in Figure 13), is expressed by the following formula:

$$\theta_{cn} = \frac{1}{K_{maxc}} \times \sum_{k=1}^{K_{maxc}} (\theta_k)_n \tag{2}$$

where

n is the time index for the instant measuring sample;

k is the index for the individual M-package;

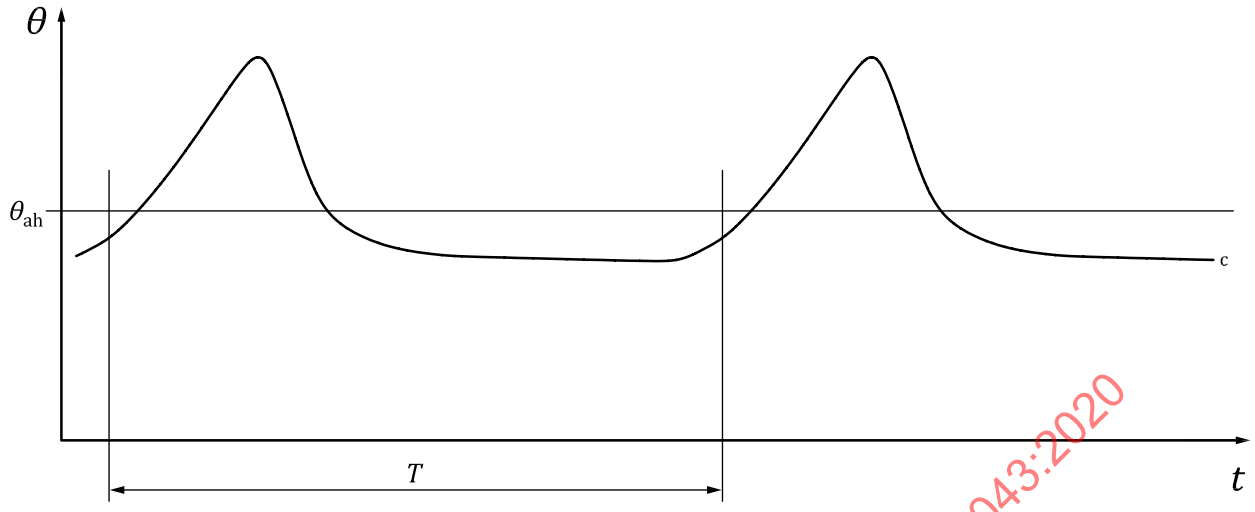
K_{maxc} is the number of all M-packages;

$(\theta_k)_n$ is the instant measured temperature of M-package k at measuring sample n.

From these average instant temperatures, the arithmetic mean temperatures of all M-packages θ_{mc} for the test period shall be calculated as follows:

$$\theta_{mc} = \frac{1}{N_{max}} \times \sum_{n=1}^{N_{max}} \theta_{cn} \tag{3}$$

where N_{max} is the number of measuring samples taken during the test period. The formula is valid only for constant time intervals during the test period.



Key

θ temperature
θ_m average mean temperature
t time
T test period
c curve c of arithmetic mean temperature of all M-packages

Figure 13 — Arithmetic mean temperature of M-packages

6.3.6.2 Lid opening sequence

The maximum temperature storage test shall include a lid opening sequence as follows. This test shall be carried out regardless of the number of lids.

Prior to the start of the 12 h lid opening period, each lid shall be opened once for 3 min. Where an ice-cream freezer is provided with more than one lid, each lid shall be opened once for 3 min consecutively.

Each lid shall then be opened six times per hour for the remaining 12 h period. Where more than one lid pertains to the ice-cream freezer under test, the sequence in which the lids are opened shall be staggered, i.e. in the case of two lids: lid 1 at 0 min, lid 2 at 5 min, lid 1 at 10 min, lid 2 at 15 min.

Sliding glass lids shall be opened beyond 80 % of the maximum area which can be opened.

Each lid opening shall be opened for a total of 6 s. During this opening period, lids shall be kept open beyond the minimum required opening, i.e. for 4 s.

Within the test period, the lids shall be opened cyclically for 12 h within 24 h. The 12 h cycle of lid opening shall start at the beginning of the test period.

6.3.6.3 Power supply

The tolerance on power supply shall be ±2 % for voltage and ±1 % for frequency in relation to the nominal values given on the marking plate or otherwise stated.

6.3.6.4 Water vapour condensation test

The ice-cream freezers shall be located and loaded in accordance with 6.3.5.1 and 6.3.5.4.5, operated in accordance with the manufacturer's instructions at the conditions appropriate to the test room climate class for which it is intended (see Table 3), and then operated for the test period according 6.3.5.7, during which measurements shall be recorded. Lighting and night-covers, if any, shall be manipulated

according to 6.3.5.8. The test may be carried out during the temperature tests as conditions described in 6.3.6.1.2 c).

If anti-condensation heaters are provided which can be switched on and off by the user they shall not be switched on. If, however, running water appears externally when the ice-cream freezer is subjected to the water vapour condensation test, the test shall be repeated with the anti-condensation heaters switched on.

Before starting the test period, all external surfaces of the ice-cream freezer shall be carefully wiped dry with a clean cloth. If the ice-cream freezer is fitted with automatic defrosting equipment this test period shall be selected during the period when condensation is most likely to occur.

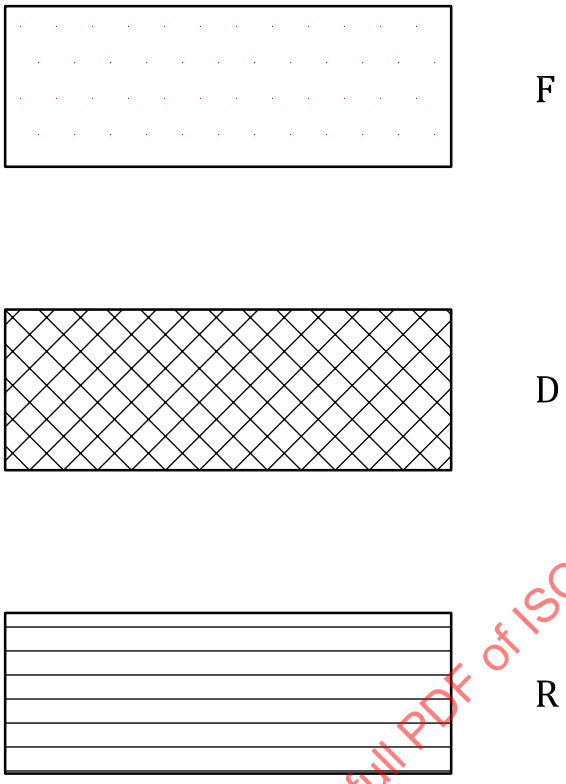
The ice-cream freezer shall be considered satisfactory if the test report shows that during the test period there is no evidence of condensed water vapour having been in direct contact with, or having dripped on to, any test packages and, depending on the method used to detect water vapour condensation, provided the following results have been obtained:

1) all ice-cream freezer surfaces, whether adjacent or otherwise, remain free of moisture by the provision of insulation, ventilation or heating to maintain a temperature above dew point of 20 °C (corresponding to 30 °C and 55 % RH);

2) internal surfaces, wherever practical, remain free of moisture collection or ice;

3) mirrors that can periodically mist during defrost clear by evaporation on the return to the refrigeration cycle.

During the test period, external surface areas exhibiting fog, droplets or running water shall be outlined and designated with the letters F, D and R respectively. A coded sketch shall be made showing the maximum area and degree of condensation appearing during the test on all surfaces; the code shown in Figure 14 shall be used.



Key

F fog/mist
D droplets
R running

Figure 14 — Condensation code

6.3.6.5 Temperature rise time test for C1 ice-cream freezers

The ice-cream freezer shall be tested at stable conditions, loaded and installed according to 6.3.5 without night covers in place and shall be located inside the test room at 30 °C and 55 % RH. After the operation of the refrigerating system has been interrupted, the time elapsed from the condition α to the condition β shall be measured and declared by the manufacturer (see Table 9).

Table 9 — Temperature rise time conditions for C1

Test room condition	Condition α warmest M-package temperature °C	Condition β warmest M-package temperature °C
30 °C – 55 % RH for class A, B, C	–18,0	–9,0

6.3.6.6 Electrical energy consumption test

6.3.6.6.1 Test conditions

The ice-cream freezer shall be located and loaded in accordance with 6.3.5.1 and 6.3.5.4.5, operated in accordance with the manufacturer's instructions at the test room ambient temperature of 30 °C at 55 % RH (6.3.6.1.2 c), and then operated for the test period according to 6.3.5.7, without the lid opening sequence, during which measurements shall be recorded. Night-covers and/or lighting, if any, shall be manipulated according to 6.3.5.8.

6.3.6.6.2 Energy consumption measurement

The measured TEC, reported in kWh/24 h (the number of decimal places shall be 3), shall include the condensing unit energy consumption, the compressor switching on/off frequency and the compressor relative running time, with all fitted electrical power-using components switched on.

6.3.6.6.3 Calculation of TEC

The total daily energy consumption expressed in kWh/24 h is calculated directly during the performance test using the instruments as defined above. The number of decimal places to express the TEC shall be 3.

6.3.6.6.4 Calculation of specific energy consumption (SEC)

The value of SEC, representing the specific energy consumption for an ice-cream freezer, measured as kWh/24 h·m^3, is calculated from the following formula:

$$SEC = TEC / V_{eq}$$

7 Test report

7.1 General

For each test carried out, general information and specific test results shall be given as follows.

7.2 Tests outside test room

— The lids seal according to the test specified in 6.2.2.

— The lids have the durability according to the test specified in 6.2.3.

— Linear dimensions, areas and volumes according to the test specified in 6.2.4 and information according to Table 10.

Table 10 — Linear dimensions, areas and volumes

Description	Symbol		Unit	Number of decimal places
External dimensions at Installation	D, H, W		mm	2
Footprint			m^2	2
Total display area	TDA		m^2	2
Net volume			l	3
			m^3	3
Gross volume			l	3
			m^3	3

— absence of odour and taste (if applicable) according to the method described in Annex D.

7.3 Tests inside test room

— General test conditions shall be in accordance with 6.3.1 and Table 11.

Table 11 — Conditions for tests inside test room

Clause n°	Description
6.3.4	Statement that the test room, all loading packages and materials and the instrumentation used are in accordance with 6.3.1, specifying if alternative for filling test packages described in 6.3.3.3 are used
6.3.2.3	Test room climate class for which the ice cream freezer is intended and in which the test has been made

— Ice-cream freezer preparation shall be in accordance with Table 12.

Table 12 — Ice-cream freezer preparation for tests inside test room

Clause n°	Description	Symbol	Unit	Number of decimal places
6.3.5.1	The ice cream freezer location within the test room using the Figure 9 presentation	X, B, Y, A	mm	0
6.3.5.4	Number of the figure according to which the ice cream freezers was loaded			—
6.3.5.5	The method of temperature control, setting parameters and sensor locations			—
6.3.5.8	Whether the test was made with or without night-covers and/or light			—
6.3.6.3	The international number of the refrigerant (see ISO 817)			—

— Temperature test shall be in accordance with 6.3.6.1 and Table 13.

Table 13 — Temperature test for tests inside test room

Clause n°	Description	Symbol	Unit	Number of decimal places
6.3.6.1.2	For ice-cream freezers fitted with night-covers and/or lights, if the results are for the maximum temperature test of 6.3.5.8 or for both tests (two sets of results shall be provided for the latter case)			
6.3.6.1.3	The time/temperature curves of the warmest M- packages and the extreme values θ_{ah} and the resulting ice cream freezer classification (see Table 1 and Figure 12)	$^{\theta}$ah	°C	1
6.3.6.1.4	The average mean temperatures of all M- packages (see also Figure 13)		°C	1
6.3.6.1.3	For temperature display systems, the sensor location and the maximum values displayed under stable operating conditions		°C	1
6.3.6.5	Time elapsed from the condition α to the condition β		h	2

— Water vapour condensation test shall be in accordance with 6.3.6.4. and Table 14.

Table 14 — Water vapour condensation test

Clause n°	Description	Symbol	Unit
6.3.6.1.2	For ice-cream freezers fitted with night-covers and/or lights, if the results are for the “first” or the “second” test of 6.3.5.8 or for both tests (two sets of results shall be provided for the latter case)		
6.3.6.4	Whether any manual switch provided for anti- condensation heaters was switched off		
6.3.6.4	The duration of the period of observation		h
	Coded sketches as defined in Figure 14		

— Electrical energy consumption test shall be in accordance with 6.3.6.6 and Table 15.

Table 15 — Electrical energy consumption test

Clause n°	Description	Symbol	Unit	Number of decimal places
6.3.6.6	Total electrical energy consumption	TEC	kWh/24 h	2
	Compressor switching on/off frequency			
	Relative compressor running time			

— Specific energy consumption calculation shall be in accordance with 6.3.6.6.4 and Table 16.

Table 16 — Specific energy consumption

Clause n°	Description				Symbol	Unit	Number of decimal places
6.3.6.6.4	Ratio between volume	TEC	and	equivalent		kWh/24 h·m^3	2

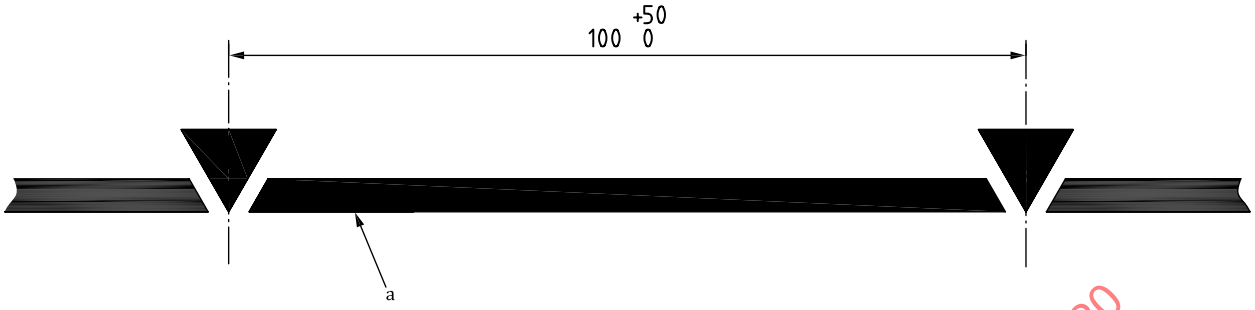
8 Marking

8.1 Load limit

Every ice-cream freezer shall be clearly and permanently marked with one or several load limit line(s) [see Figure 15 b)], on the inside face, as shown in Figure 16, to denote the load limit. Where it is not possible to exceed the load limit, no marking is required.

The load limit line shall be continuous [see Figure 15 a)] or repeated at intervals [Figure 15 b)] to ensure that it cannot be overlooked. Individual markings shall be at least 50 mm long and shall contain at least one equilateral triangle with side dimension, d, included within 5,5 mm and 15 mm (see Figure 16).

Dimensions in millimetres



a) Continuous load limit line

b) Load limit line repeated at intervals

[a] This denotes the load limit.

Figure 15 — Load limit markings

Dimensions in millimetres

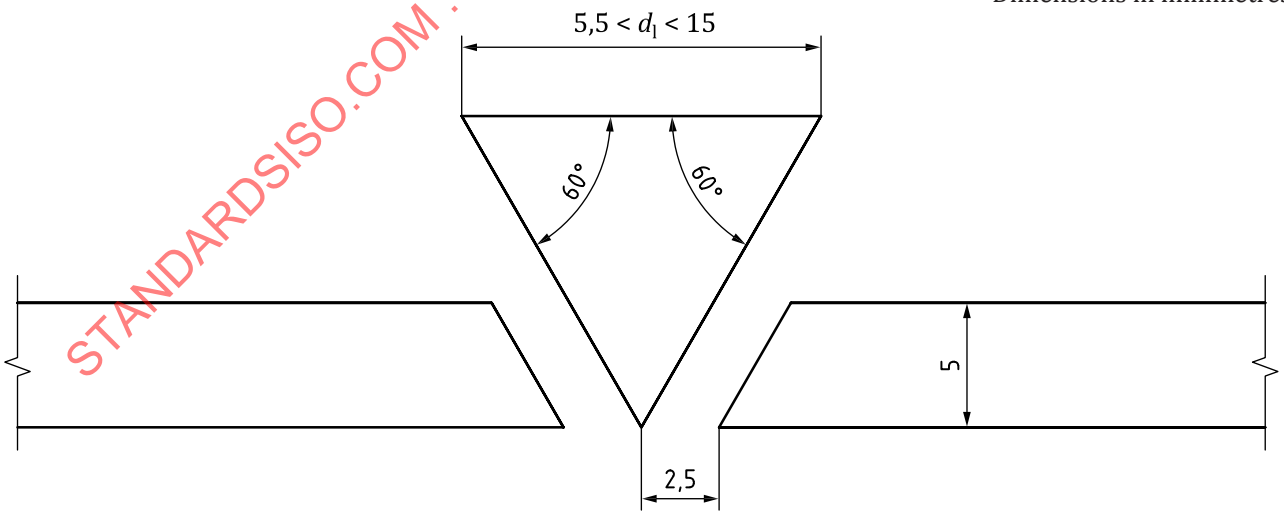


Figure 16 — Dimensions of load limit line

Where a load limit line cannot be marked on the inside face because of ice-cream freezer design, an outline sketch showing the load limit shall be fixed in a visible position and in the manufacturer's instruction handbook (see Figure 17).

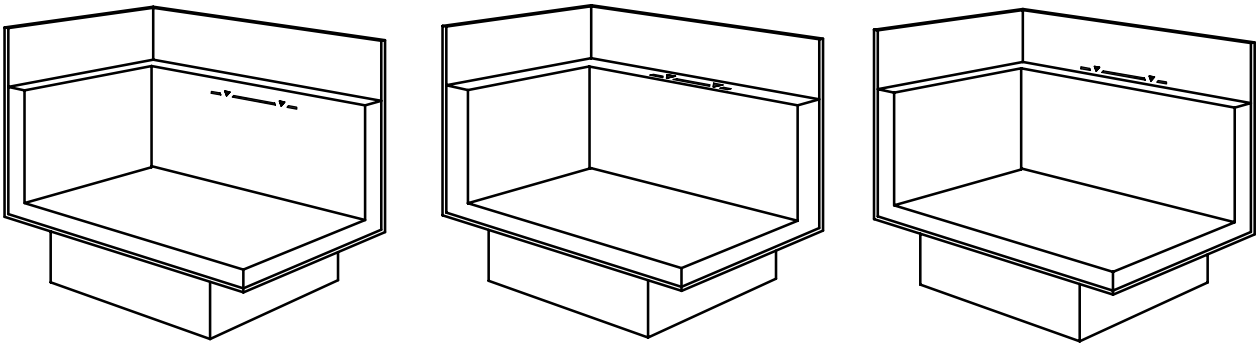


Figure 17 — Different positions for the load limit

8.2 Marking plate

Each ice-cream freezer shall have the following information marked in a permanent and legible manner in locations where it is readily accessible:

a) the reference to this document, i.e ISO 22043;

b) ice-cream freezer;

c) the manufacturer's name or trademark or both (not necessarily the same name as that of the condensing unit);

d) model and serial number of the ice-cream freezer, integral condensing unit(s), etc., or sufficient information to provide adequate identification for replacement of parts or necessary servicing;

e) a description of the ice cream freezer's internal fittings;

f) all information relating to the power supply for which the ice-cream freezer is designed;

g) the international number of refrigerant(s) (see ISO 817) used and its (their) mass, in grams;

h) marking in accordance with ISO 5149-2;

i) the M-package temperature class;

j) the test room climate class;

k) for ice-cream freezer classified as S it shall be indicated: ambient temperature, ambient humidity, product temperature range; e.g.: S (27 °C/58 %/–15 °C~–5 °C).

8.3 Information to be supplied by the manufacturer

The following information shall be provided by the manufacturer for each ice-cream freezer model.

a) Overall external dimensions at installation.

b) Overall external dimensions in service (see 6.3.5.1).

c) For each indicated M-package class (see 5.1):

   1) net volume and equivalent volume (see 6.2.5);

   2) the maximum load, in kilograms, permitted in the baskets or on the base deck for the various methods of arranging them in the ice-cream freezer;

3) for ice-cream freezers fitted with night-covers and/or lights,

   i) the electrical energy consumption, in kilowatt hours per 24 h, measured in accordance with the test described in 6.3.6.6,

   ii) the specific energy consumption SEC; in kilowatt hours per 24 h per m^3 of equivalent volume.

d) For each test room climate class in which the ice-cream freezer operates, the manufacturer shall furnish the following temperature display information, according to the measured results in the test (see 6.3.5):

   — location of the temperature sensor;

   — maximum values displayed by the instrument or measured at the sensor location in stable operating conditions;

   — maximum value displayed by the instrument or measured at the sensor location at the warmest moment during or just after the defrosting period;

   — conditions where the display of temperature may be interrupted (for example during defrosting).

Annex A
(informative)

Ice-cream freezer families

The ice-cream freezer families are described in Table A.1.

Table A.1 — Example

Ice-cream freezer family	Symbol
Closed transparent lid	ICFT
Closed solid lid	ICFS