
**Refrigerated storage cabinets and
counters for professional use —
Performance and energy consumption**

*Armoires et comptoirs frigorifiques de stockage destinés à un usage
professionnel — Performances et consommation d'énergie*

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Fax: +41 22 749 09 47
Email: copyright@iso.org
Website: www.iso.org

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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.

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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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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*.

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.

Refrigerated storage cabinets and counters for professional use — Performance and energy consumption

1 Scope

This document specifies requirements for the verification of performance and energy consumption of refrigerated storage cabinets and counters for professional use in commercial kitchens, hospitals, canteens, preparation areas of bars, bakeries, gelateria, institutional catering and similar professional areas.

The products covered in this document are intended to store foodstuffs. It specifies test conditions and methods for checking that the requirements have been satisfied, as well as classification of the cabinets and counters, their marking and the list of their characteristics to be declared by the manufacturer.

It is not applicable to:

- refrigerated cabinets used in the direct sale of foodstuffs;
- cabinets that carry out food processing and not just storage function (e.g. bakery cabinets that chill, heat and humidify);
- cabinets with water cooled condenser;
- appliances with remote condensing unit;
- appliances with open top tables and saladettes for preparation or storage of foodstuffs;
- cabinets specifically intended for storage of specific foodstuffs (i.e. fresh meat, fresh fish, etc.) operating at a temperature different from those specified in [Table 1](#);
- chest freezers;
- appliances intended for short time /intermittent normal operation during the full day;
- built-in cabinets;
- roll-in cabinets;
- pass-through cabinets;
- ice cream freezers.

2 Normative references

There are no normative references in this document.

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:

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

refrigerated storage cabinet

cabinet cooled by an incorporated refrigerating system which enables chilled and frozen foodstuffs placed therein to be maintained within prescribed temperature limits

Note 1 to entry: Refrigerated storage cabinets are supplied with:

- transparent door: door where the transparent part is more than 20 % of the surface of the door;
- solid door: door where the transparent part is less than 20 % of the surface of the door.

3.1.1

vertical cabinet

refrigerated storage cabinet (3.1), having overall height equal or higher than 1 050 mm with one or more front doors or drawers accessing the same compartment

3.1.2

counter cabinet

refrigerated storage cabinet (3.1), having overall height lower than 1 050 mm, with one or more front doors or drawers accessing the same compartment

3.1.3

roll-in cabinet

refrigerated cabinet intended to be loaded with trolleys with shelves and designed to be introduced as such in the compartment

3.1.4

pass-through cabinet

refrigerated cabinet accessible from both sides

3.1.5

semi-professional or light duty cabinet

refrigerated cabinet for which the measurement of energy consumption and the capability of maintaining temperature in the compartment are verified when tested at test room climate class 3

3.1.6

normal duty cabinet

refrigerated cabinet for which the measurement of energy consumption and the capability of maintaining temperature in the compartment are verified when tested at test room climate class 4

3.1.7

heavy duty cabinet

refrigerated cabinet for which the verification of the capability of maintaining the temperature in the compartment is performed when tested at test room climate class 5 and the measurement of energy consumption is verified when tested at test room climate class 4

3.1.8

static air cabinet

cooling system without fan inside the cabinet, or system in which the fan can be switched off by the user

3.1.9

built-in cabinet

refrigerated storage cabinet (3.1) intended to be installed into a prepared recess in a wall or similar location and requiring furniture finishing

3.1.10

refrigerator

appliance where the chilled foodstuff is stored at temperature corresponding to that of class M1

3.1.11

freezer

appliance where the frozen foodstuff is stored at temperature corresponding to that of class L1

3.1.12**combined refrigerated cabinet**

refrigerated cabinet with different temperatures for chilled and/or frozen foodstuffs in separate compartments of the same cabinet

3.1.13**multi use refrigerated cabinet**

refrigerated cabinet or separate compartment of the same cabinet that may be set at different temperatures for chilled or frozen foodstuffs

3.1.14**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)

3.2**commercial kitchen**

area in commercial premises where foodstuffs are processed and stored

Note 1 to entry: This area also includes counter area in a bar.

3.3**overall external dimensions**

dimensions of the right parallelepiped bounded by the length, depth and height of the cabinet, including its projecting accessories

3.4**net volume**

volume containing foodstuffs within the load limit

3.5**shelf**

surface, excluding the base deck, on which the goods are stored

3.6**shelf sham**

device intended to limit the loading of a shelf surface

3.7**shelf area**

area defined by the external dimensions of the *shelf* (3.5) or internal dimensions of the base of the drawer

Note 1 to entry: The shelf area used for the calculation of volume is different from the area loaded with packages as given in 5.3.3.3.

Note 2 to entry: In case of shelves that are recessed into the cabinet walls the recess part is not considered for the calculation of the surface area.

3.8**load limit**

each part of the cabinet boundary surface consisting of a plane or several planes within which foodstuffs can be loaded

3.9**load limit line**

permanently marked boundary line denoting the limit of the loading surface

3.10

operating conditions

conditions which exist when the cabinet, including all permanently located accessories, has been set up with the recommendations of the manufacturer and is in service

Note 1 to entry: Specific operating conditions are defined in [Clause 5](#).

3.11

defrosting

removal of frost, snow and ice from a refrigerated cabinet

3.11.1

automatic defrosting

defrosting ([3.11](#)) where no action is necessary by the user to initiate the removal of frost accumulation and to restore normal operation

Note 1 to entry: It includes automatic removal of defrost water.

3.11.2

semi-automatic defrosting

defrosting ([3.11](#)) where an action is necessary by the user to initiate the removal of frost accumulation and operating condition is restored automatically

Note 1 to entry: It either includes automatic removal of defrost water or entails manual removal of defrost water.

3.11.3

manual defrosting

defrosting ([3.11](#)) where an action is necessary by the user to initiate the removal of frost accumulation and restoration to normal operation requires a further action by the user

Note 1 to entry: It either includes automatic removal of defrost water or entails manual removal of defrost water.

3.12

defrost water removal

process through which defrost water is removed from a refrigerated cabinet

3.12.1

automatic removal of defrost water

removal and/or evaporation of defrost water that does not require any action by the user

3.12.2

manual removal of defrost water

removal of defrost water that requires an action by the user

3.13

condensing unit

combination of one or more compressors, condensers and liquid receivers (when required) and common accessories

3.14

compression-type refrigerating system

system 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)

3.15

indirect-type refrigerating system

system in which a secondary refrigerant circulating system is installed between a central refrigerating system and a refrigerated cabinet

3.16**frame heating**

system to avoid condensation on the frame surface and freezing of the gasket of the refrigerated cabinet

3.17**energy consumption****E24h**

energy consumption of the refrigerated cabinet in kWh

3.18**M-package**

test package fitted with a temperature measuring sensor at its geometric centre

3.19**M-package temperature class**

classification of *M-package* (3.18) temperature according to temperatures of *M-packages* during the temperature test

3.20**climate class**

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

3.21**drawer**

retractable device for food storage, not located behind a door and accessible directly from the front of the cabinet

3.22**cabinet section**

vertical part of a cabinet compartment containing one or more doors or *drawers* (3.21) placed above each other

4 Requirements**4.1 Condensate drainage**

Where drains, drip trays or evaporation receptacles are fitted, they shall have a capacity such to avoid overflow immediately during the testing period of 5.3.3.6.1 and whenever relevant (e.g. in case of manual cleaning), specific instructions shall be given on how to access and clean them.

4.2 Operating characteristics**4.2.1 Classification according to temperature**

The temperatures measured in the compartment(s) shall comply with the values specified in Table 1 and the tests shall be carried out as specified in 5.3.4.

Table 1 — M-package temperature classes

Class	Highest temperature, θ_{ah} , of warmest M-package less than or equal to (see Figure 11)	Lowest temperature, θ_b , of coldest M-package greater than or equal to (see Figure 11)	Lowest temperature, θ_{al} , of warmest M-package less than or equal to (see Figure 11)
	°C		
L1	-15	—	-18
M1	+5	-1	—

4.2.2 Defrosting

The proposed defrosting procedures (automatic or manual) shall not affect the temperature requirements (see [5.3.4](#)).

4.2.3 Electrical energy consumption

The electrical energy consumption (E24h) shall be measured over a 24 h period according to the conditions and the test methods specified in [5.3.5](#).

The energy consumption shall be expressed in kWh/24 h rounded to two decimal places.

5 Test conditions

5.1 General

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

Compartment(s) of a combined refrigerated cabinet that are not foreseen for storage of foodstuffs are not subjected to tests and verifications of this document.

[Table 2](#) lists the tests and verifications.

Table 2 — Test summary

Tests and inspections	Test method	Test room
Temperature	5.3.4	Inside test room (see 5.3)
Defrosting	4.2.2	
Electrical energy consumption	5.3.5	
Calculation of net volume	6.1	Outside test room (see 5.2)

5.2 Tests outside test room

The tests which may be carried out outside the test room deal with the verification of physical dimensions, linear dimensions, areas and volumes.

Measurements shall be made with the cabinet not in operation but situated in a place where the temperature is maintained between 16 °C and 30 °C.

If the cabinet includes permanent jacks, rollers, feet or other components for adjustment of height, they are considered in the measurement of the height of the cabinet. The height for the counter shall not include the work top.

5.3 Tests inside test room

5.3.1 General

The tests which are carried out inside the test room deal with the measurement of the following characteristics:

- temperature and defrosting;
- electrical energy consumption.

5.3.2 Test conditions

5.3.2.1 General

In the following, general testing conditions which are common for all tests specified in [Clause 6](#) carried out inside the test room are defined. These conditions concern the test room, the test and M-packages, and the measuring instruments.

5.3.2.2 Test room — General design, walls, floor and radiant heat

The test room shall be a parallelepiped space. The walls of the room shall be thermally insulated.

The minimum dimensions of the test room shall be such as to allow at least 0,5 m above the top of the cabinet, 1 m on the side of the climate measuring point, 0,5 m on the opposite side and 1,5 m on the front of the cabinet with doors in closed position (see [Figure 4](#)).

A minimum insulation level equivalent to 60 mm of rigid polyurethane foam ($\lambda = 0,03 \text{ W/m } ^\circ\text{C}$) should be used for the building of the 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 $(600 \pm 100) \text{ lx}$ measured at a height of 1 m above the floor level and shall be lit continuously during the test period.

The walls, ceilings and any partitions of rooms intended for the testing of refrigerated cabinets shall have an emissivity between 0,9 and 1 at $25 \text{ }^\circ\text{C}$.

5.3.2.3 Test room climate definition

5.3.2.3.1 Test room 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 $\pm 1 \text{ }^\circ\text{C}$ of the temperature and ± 5 units of the relative humidity percentage figures at the specified climate measuring point(s).

Table 3 — Climate classes

Test room climate class	Dry bulb temperature $^\circ\text{C}$	Relative humidity %	Dew point $^\circ\text{C}$	Water vapour mass in dry air g/kg
3	25	60	16,7	12,0
4	30	55	20,0	14,8
5	40	40	23,9	18,8

NOTE The water vapour mass in dry air is one of the main points influencing the performance and the energy consumption of the cabinets.

5.3.2.3.2 Climate measuring point

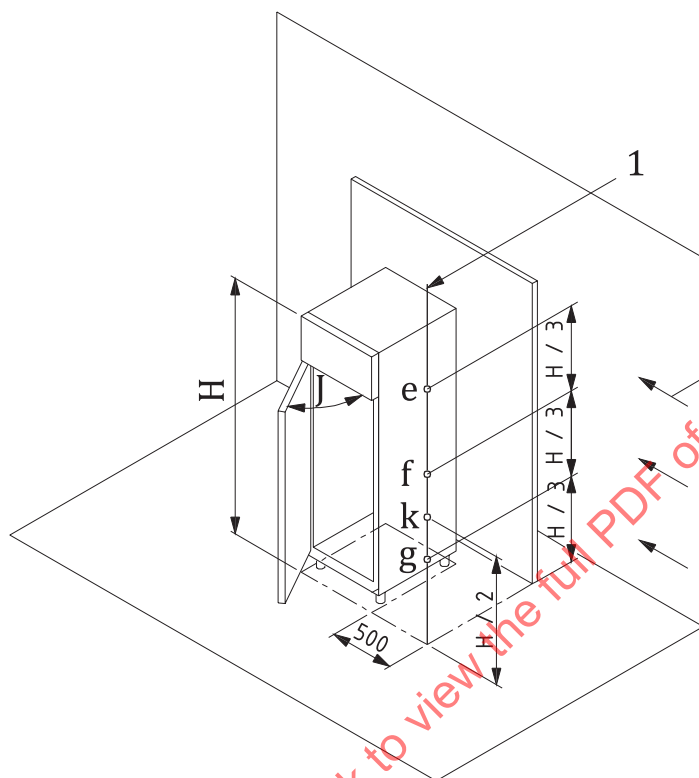
The climate measuring point shall be located in the test room air flow, 500 mm upstream of the cabinet (i.e. on the air supply side of the cabinet), in line with the front of the cabinet at a vertical height that is half the cabinet height (including cabinet feet and fixings).

To avoid undue influence from the movement of doors or of doors operating means, for the value of the relative humidity, the mean of the relative humidity values measured during 1 min shall be considered.

The warm condenser air flow shall be prevented from influencing the temperature at the measuring point by air deflectors or other suitable means.

Positioning and type of air deflectors if any shall be indicated. This information is included in the information foreseen in [Annex A](#).

Dimensions in millimetres



Key

- | | |
|---------|---|
| 1 | climate measuring line |
| H | overall height of cabinet including feet or castor |
| J | opening angle of cabinet door during test ($\geq 60^\circ$) |
| e, f, g | climate measuring points detecting air flow |
| i | air currents parallel to the plane of the door opening |
| k | climate measuring point detecting temperature and humidity |

Figure 1— Environmental measuring points within the climate chamber

5.3.2.3.3 Temperature gradient

The temperature gradient shall be measured with the cabinet operating in the test room and with the doors and drawers closed. Temperatures shall be measured in a vertical line through the climate measuring point. The temperature gradient shall not exceed 2 °C/m and there shall not be a difference of more than 6 °C in the measurements made between the points 150 mm above the floor and 150 mm below the ceiling.

5.3.2.4 Test packages characteristics

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.

Each test package shall consist of filling material and a wrapper. Filling material containing, per 1 000 g:

- 230,0 g of oxyethylmethylcellulose ± 1 g;
- 764,2 g of water ± 1 g;
- 5,0 g of sodium chloride $\pm 0,1$ g;
- 0,8 g of para-chlorometa-cresol $\pm 0,1$ g.

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 $(-1 \pm 0,5)$ °C (see [Figure 2](#), [Table 5](#) and [Table 6](#)).

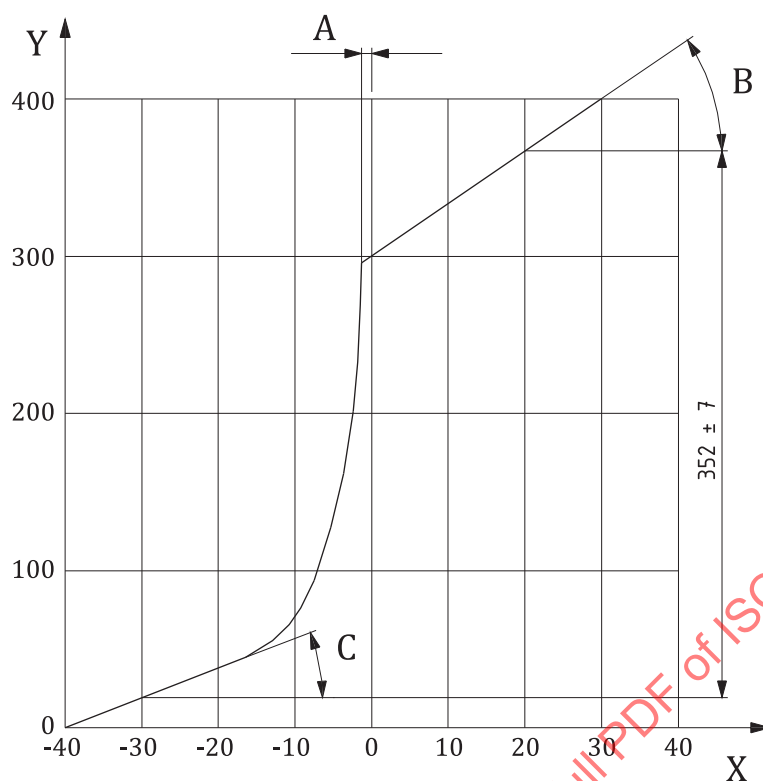
Up to 4 % of water should be added in order to compensate for evaporation during the preparation of the filling material.

Table 4 — Dimensions and mass of test packages

Dimensions (height × width × length) mm	Mass g
50 × 100 × 100	500
50 × 100 × 200	1 000
The following packages may be used as fillers to complete the cabinet loading:	
25 × 100 × 200	500
25 × 100 × 100	250
25 × 50 × 100	125
37,5 × 100 × 100	375

Each test package shall be wrapped in a sheet of light coloured plastic or any other suitable material of such nature that exchange of moisture with the ambient medium is negligible. The maximum total thickness shall be 1,0 mm. After filling this sheet shall be sealed.

The correspondence of the packages' material composition with the above-mentioned characteristics should be certified by the supplier or by an independent laboratory.

**Key**

X temperature, °C

Y specific enthalpy, kJ/kg

A $\Delta\sigma = (1 \pm 0,5) ^\circ\text{C}$ B $k = (3,7 \pm 0,4) \text{ kJ} \times (\text{kg} \times \text{K})^{-1}$ C $k = (2 \pm 0,2) \text{ kJ} \times (\text{kg} \times \text{K})^{-1}$ **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

Table 5 (continued)

Temperature °C	Specific enthalpy kJ/kg
-5	114
-4	129
-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

5.3.2.5 M-packages

Some of the 500 g packages (50 mm × 100 mm × 100 mm) specified in 5.3.2.4 shall be equipped for temperature measurement, being fitted with temperature sensors inserted in the geometrical centre of the packages in direct contact with the filling material (see Figure 3).

NOTE Sensors inserted into a sheath can be used, but the sensor and sheath are calibrated as a single entity.

The diameter of sensor cable shall be maximum 3 mm and the diameter of the sensor shall be maximum 5 mm.

If sensors consist of more than one wire the total section of the wires and insulation shall be calculated and shall be less than 7,1 mm².

The insulation material of the sensor lead shall be embodied within the M-package of a minimum 15 mm.

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.

Dimensions in millimetres

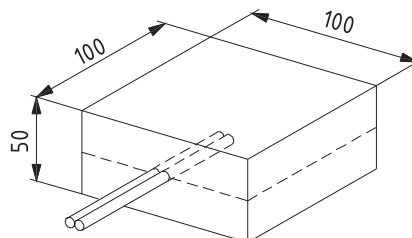


Figure 3 — M-Package

5.3.2.6 Test packages life time

Due to the frequency of use and to the loading pressure, the package could change in dimensions and weight. All test packages shall be checked annually for conformity with the following life-time tolerances:

- a) Loss of mass: -5% .
- b) On the wrapper: no visible hole.
- c) Change in linear dimensions:
 - 1) ± 4 mm for dimensions between 25 mm and 50 mm;
 - 2) ± 8 mm for dimensions 100 mm and 200 mm.

When a test package is found to exceed one of the tolerances, it shall be replaced.

5.3.2.7 Instruments, measuring equipment and measuring accuracy

All measurements shall be carried out with instruments that have been calibrated. The following measurement accuracies shall be met:

- Temperature measurements shall be made to an accuracy of $\pm 0,8\text{ }^{\circ}\text{C}$. Climate temperatures shall be measured by sensors, inserted in the centre of tinned solid copper or copper-zinc alloy cylinders having a mass of $25\text{ g} \pm 1\text{ g}$ and of minimum external area (diameter = height = approximately 15,2 mm).
- Illumination flux per square metre shall be measured to an accuracy of 10% .
- Relative humidity shall be measured to an accuracy of ± 3 units.
- Electrical energy consumption shall be measured to an accuracy of 2% (see [5.3.5](#)).
- Air velocity shall be measured using a laboratory-type instrument with an accuracy of 10% or $\pm 0,03\text{ m/s}$ whichever is the greater and with a minimum sensitivity of $0,03\text{ m/s}$ in the range of 0 m/s to $1,5\text{ m/s}$ in horizontal flow at the temperature of the selected ambient class.
- time interval measurements shall be made to an accuracy of at least 1% .
- measurement on linear dimensions shall be to an accuracy of $\pm 2\text{ mm}$.

5.3.2.8 Alternative for filling test packages

Alternative filling test packages having the dimensions shown in [Table 4](#) and density of $(480 \pm 80)\text{ kg/m}^3$ can be used, except for rows (see [5.3.3.3.1](#)) and columns containing M packages, see [Figure 8](#).

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 of the case shall not result in protrusions sufficient to cause significant air gaps between adjacent packages.

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, plastics or cellulose sponge.

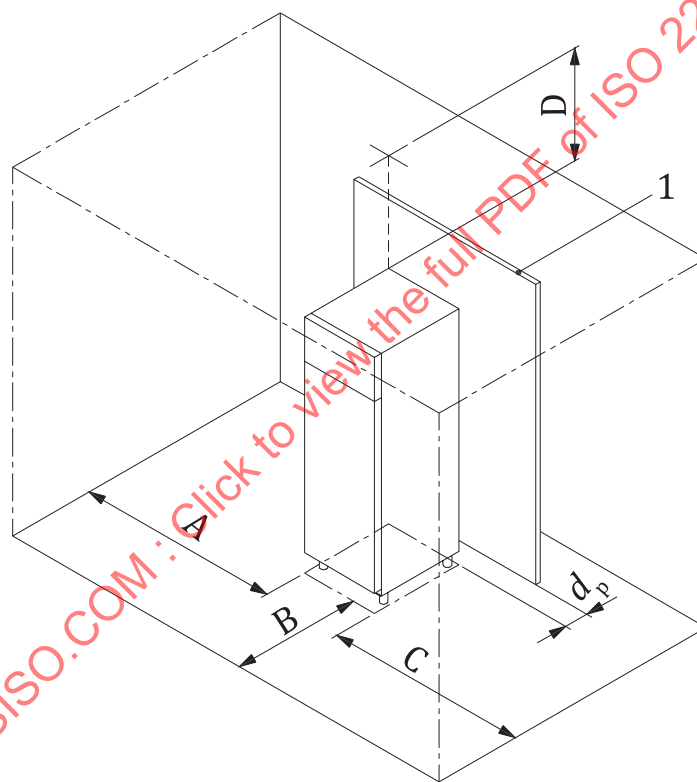
5.3.3 Preparation of test cabinet

5.3.3.1 Cabinet selection, installation and positioning within the test room

Each refrigerated cabinet intended to be tested, unless a prototype, shall be selected from stock or routine production and shall be representative as to construction and adjustment.

The cabinet, 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.

Cabinets shall be placed against a wall of the test room or a vertical partition with an emissivity between 0,9 and 1 at 25 °C having a length of at least 1 m on the side of the climate measuring point, 0,5 m on the opposite side and an height of at least 0,5 m more than the cabinet under testing at a distance from the rear as specified in the instructions for use (see [Figure 4](#)).



Key

- 1 vertical partition (if used) in place of wall
- d_p clearance between rear wall of test room or vertical position specified by the manufacturer (if used)
- A minimum distance from side wall of test room
- B minimum distance from front wall of test room
- C minimum distance from side wall of test room
- D minimum distance from the ceiling

Figure 4 — Positioning of the cabinet within the climate chamber

5.3.3.2 Air movement

Air movement shall be provided. The air movement, shall be, as far as practicable, parallel to the plane of the cabinet opening and to the longitudinal axis. The length of the cabinet is defined as the longest horizontal dimension of the opening.

Air velocity shall be measured in a vertical line through the climate measuring point with the cabinet in operation and with the doors or drawers closed. The air velocity at one third, two thirds, three thirds of the overall height of the cabinet shall be between 0,1 m/s and 0,2 m/s.

The direction of air flow shall be such that the air enters the cabinet when the door(s) is (are) open. For refrigerated cabinets with multiple doors, 50 % or more of the doors shall open into the direction of the air.

5.3.3.3 Loading the cabinet

5.3.3.3.1 General

The cabinet shall be loaded with test packages (see [5.3.2.4](#) and [5.3.2.8](#)) and M-packages (see [5.3.2.5](#)) up to half the load limit, as illustrated in [Figures 5](#) to [8](#).

Test packages with a mass of 1 000 g and 500 g shall be used.

To complete the loading, test packages of the following sizes (height × width × length) shall be used as fillers:

- 25 mm × 100 mm × 200 mm
- 37,5 mm × 100 mm × 100 mm
- 25 mm × 100 mm × 100 mm
- 25 mm × 50 mm × 100 mm

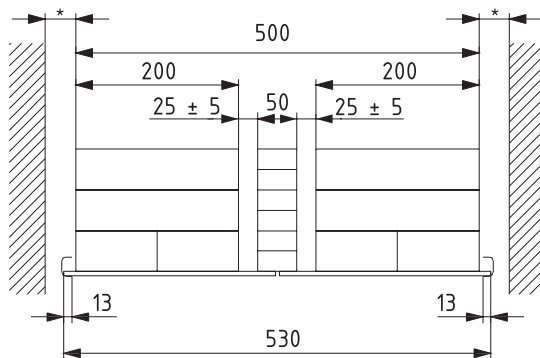
The test packages shall be arranged so as to form an even level.

Each refrigerated shelf area shall be loaded with test packages arranged in such a way that they form rows with a length of 200 mm by the depth of the cabinet shelf or drawer base or container. In case this condition is not possible due to the size of the shelf or drawer base or container, evenly distributed rows as close as possible to 200 mm shall be used.

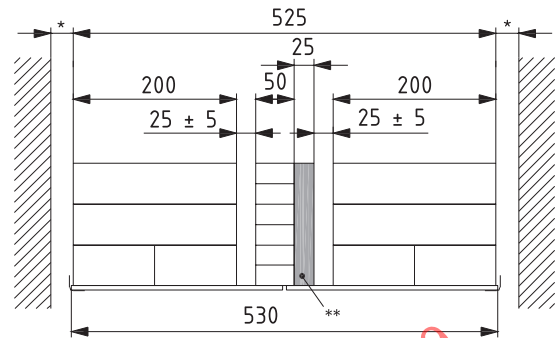
A clearance of 25 mm ± 5 mm shall be left between package rows. If the clearance is limited by construction, the packages adjacent to the side walls shall be loaded to the shelf extremity (see [Figures 5](#), [6](#) and [7](#)).

Otherwise the clearance of the extreme package close to the walls shall be as close as possible to 25 mm.

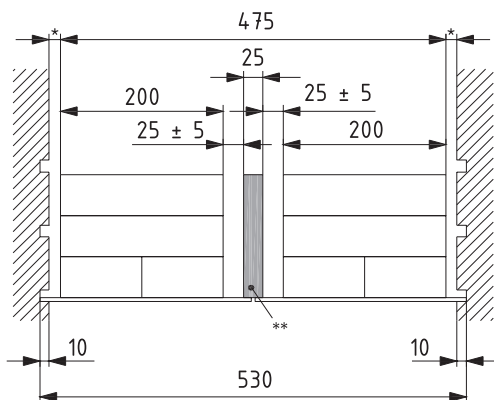
Dimensions in millimetres



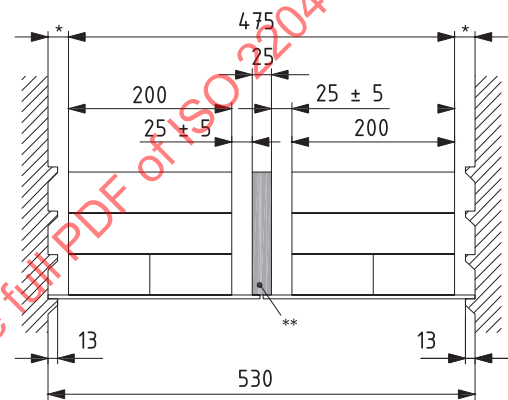
a) Shelf with "U" shape shelf support



b) Shelf with "L" shape shelf support



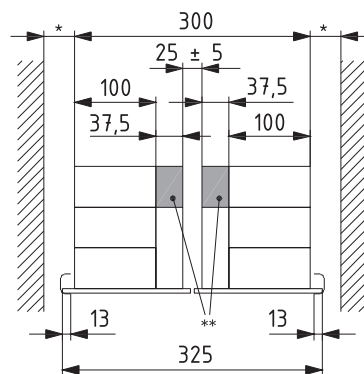
c) Shelf support integrated into the wall, type 1



d) Shelf support integrated into the wall, type 2

a) Examples of loading of 530 mm wide shelves front view

Packages should be loaded to the rear extremity and front extremity of the cabinet shelf or drawer unless this is limited by construction or by a specific load limit line.



b) Example of loading of 325 mm wide shelves front view

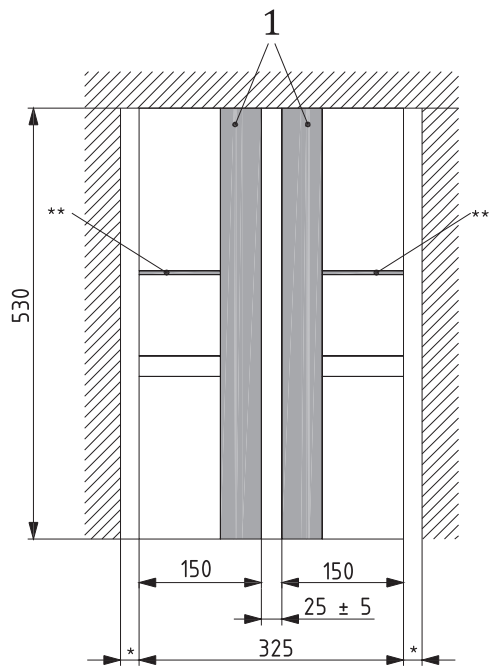
* As close as possible to 25 mm.

** Wooden dividers.

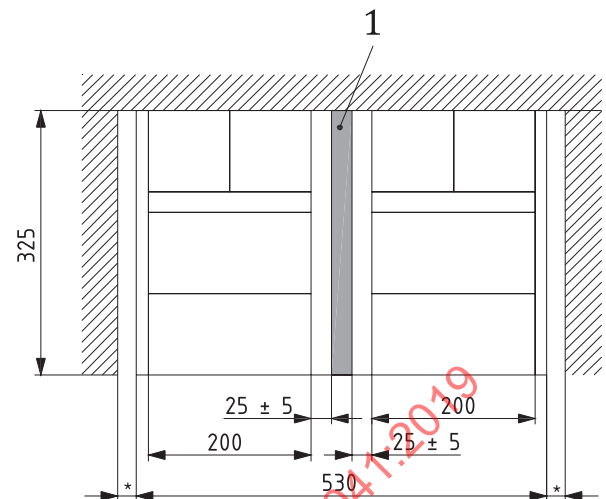
Figure 5 — Examples of shelves loading, front view

In the case of drawers, the clearance of the extreme package close to the side of the container or of the drawer shall be as close as possible to 25 mm (see [Figure 7](#)).

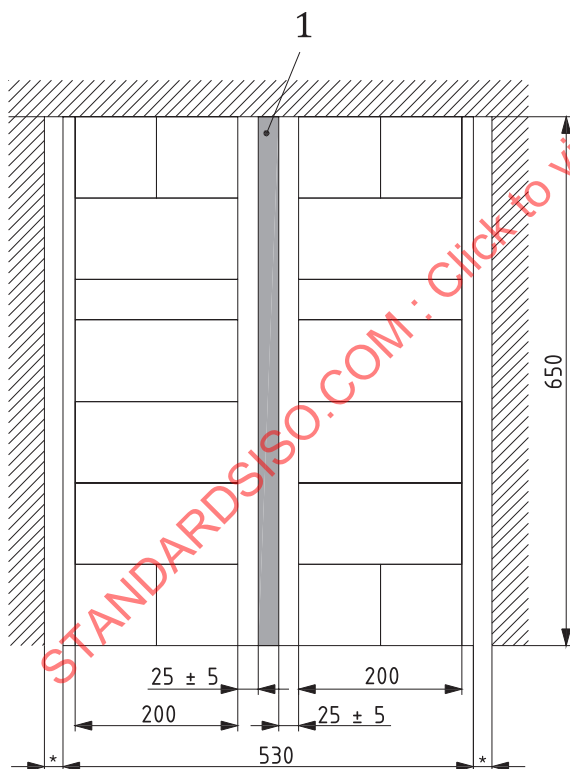
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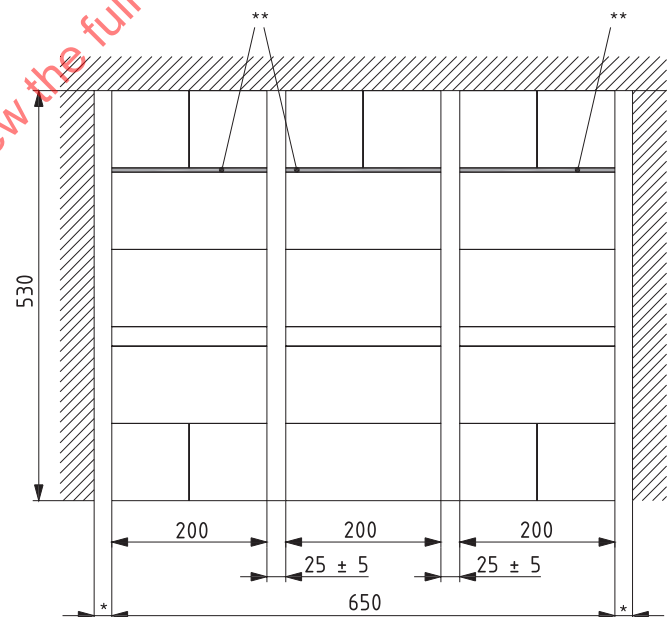
a) 325 mm wide shelves in depth



b) 325 mm wide shelves in width



c) 530 mm wide shelves in depth



d) 530 mm wide shelves in width

Key

- 1 fill packages and wooden divider
- * As close as possible to 25 mm.
- ** Wooden dividers.

Figure 6 — Examples of shelves loading, top view

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, any remaining spaces shall be filled with test packages depth-wise and width-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. A support system not influencing the temperature distribution inside the cabinet may be used to support the test packages or the fillers.

In case the required clearance of $25 \text{ mm} \pm 5 \text{ mm}$ between package rows cannot be maintained, special shelves and support systems, not influencing the loading pattern and the temperature distribution inside the cabinet may be used for this test purpose only. The special shelves shall not be considered for the calculation of the net volume as in 6.1.

5.3.3.3.2 Loading heights

The loading height of the refrigerated shelves shall be as follows:

- a) For refrigerated storage cabinets with drawers, the loading height shall be equal to half of the height defined by the load limit line of the drawer, with a tolerance of $^{+25}_0 \text{ mm}$ (see Figure 7). In the case of a drawer that does not have a base where the load can be placed, the container with maximum dimensions and material declared by the manufacturer shall be used.

Examples of loading in case of drawers with special configurations are given in Figure 7.

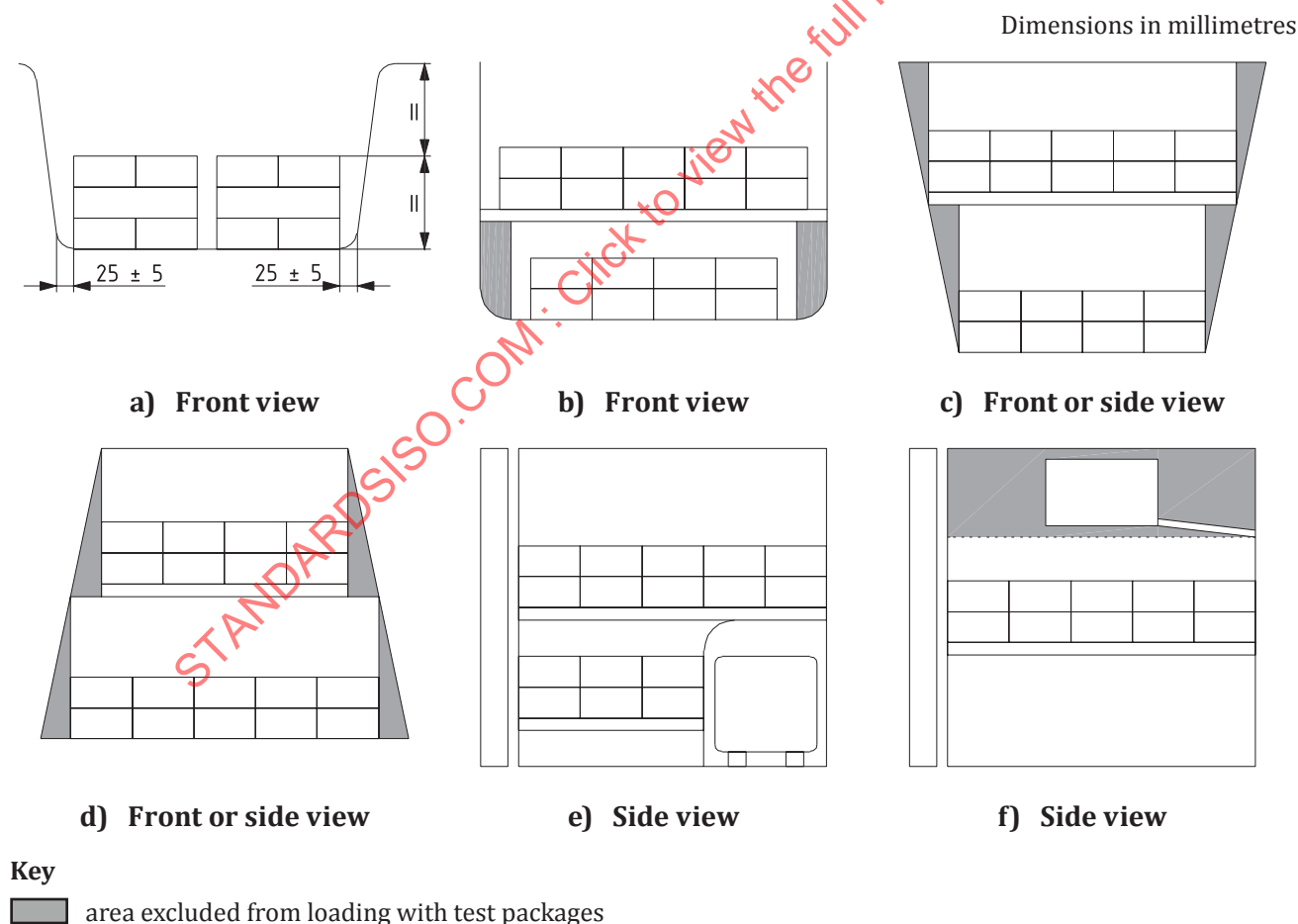


Figure 7 — Examples of loading configurations

- b) For refrigerated storage cabinets that allow shelves to be put in different positions by the user the number of shelves to be used is calculated by dividing by 300 mm the vertical distance from the

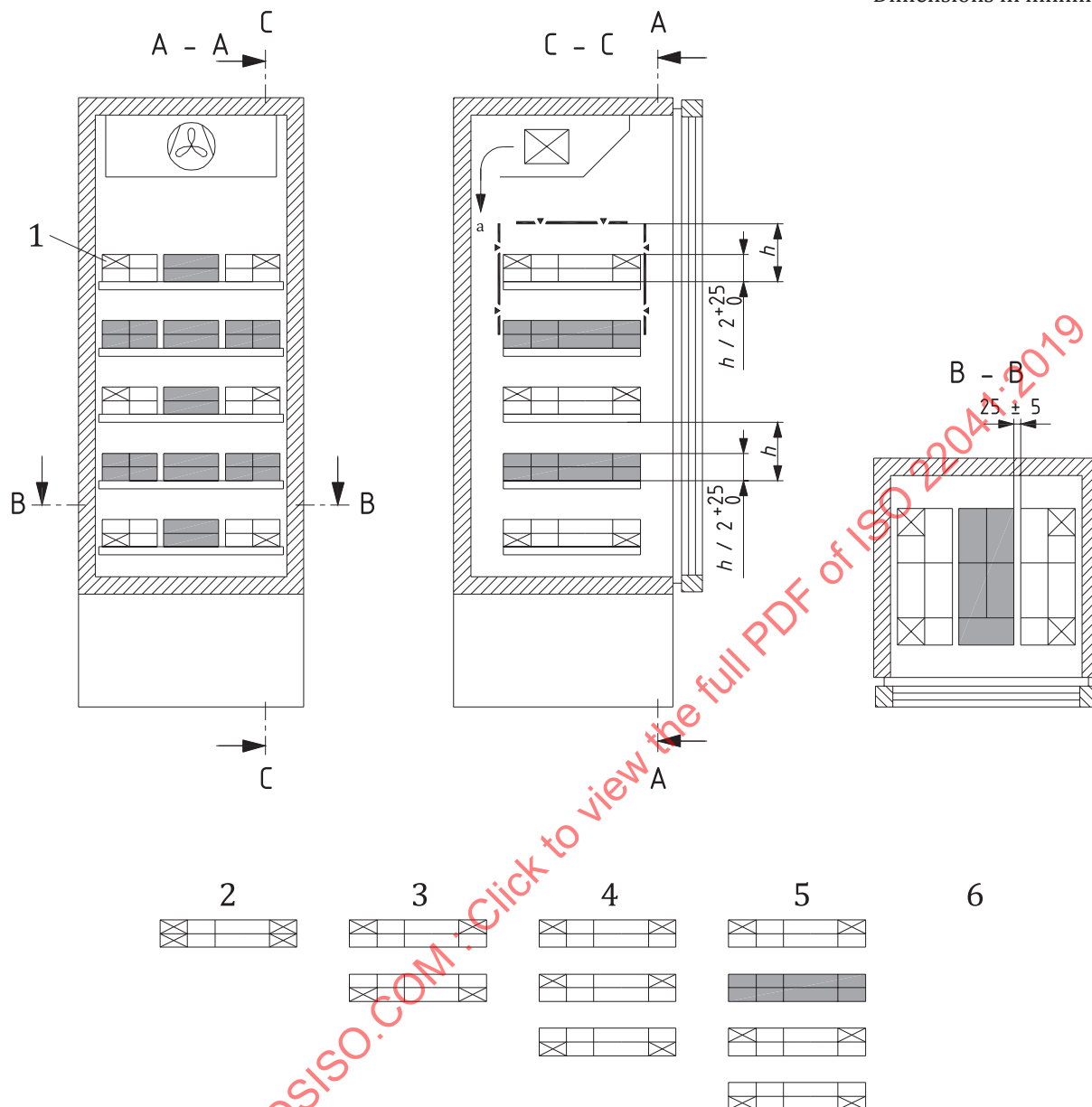
surface of the lowest shelf or loadable surface to the load limit line. The number of shelves resulting shall be rounded to the nearest lowest integer, with a minimum of one shelf to be used.

The lowest shelf shall be located at the lowest available fitting. The remaining shelves shall be placed at as much as possible equal distance apart. The loading height shall be equal to half of the distance between shelves or where there is a load limit line, half of the distance to the load limit line, with a tolerance of $^{+25}_0$ mm (see [Figure 8](#)).

- c) For refrigerated storage cabinets with fixed shelves, the loading height shall be equal to half of the distance between shelves, or where there is a load limit line, half of the distance to the load limit line with a tolerance of $^{+25}_0$ mm (see [Figure 8](#)).

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Dimensions in millimetres

**Key**

- 1 M-package
- 2 1 level
- 3 2 levels
- 4 3 levels
- 5 4 levels
- 6 5 levels (see main illustration)
-  pattern positioning the alternative filling package
- h distance between shelves or between top shelf and load limit

Figure 8 — Example of loading scheme for vertical cabinets

The base of the cabinet may be considered as shelf if it is indicated in the instructions for use as suitable for storing of goods.

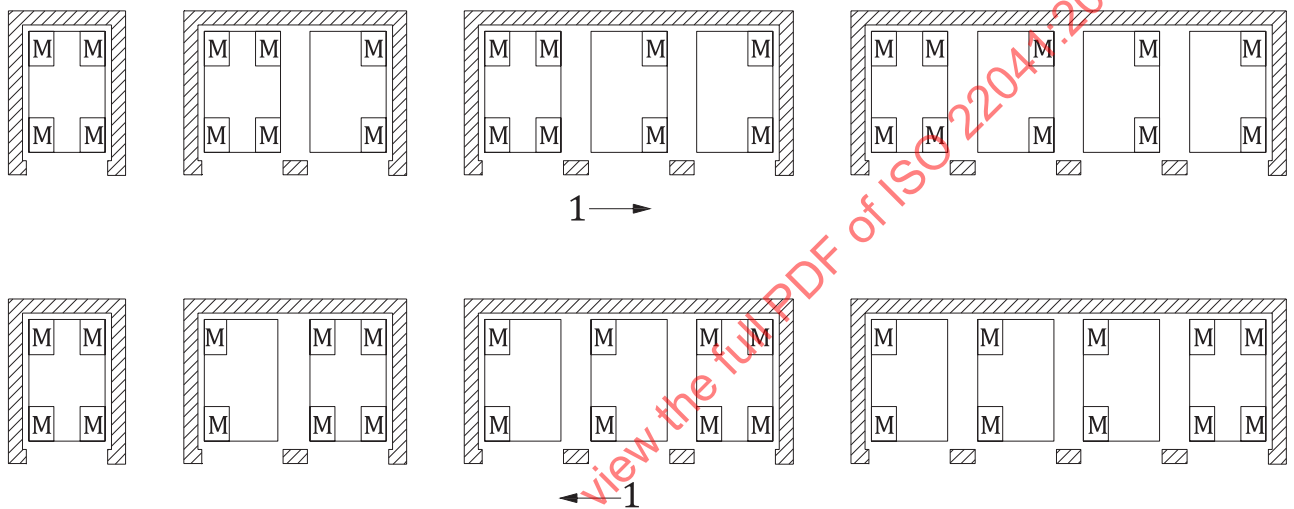
5.3.3.3.3 M-package locations

M-packages shall be located as indicated in 5.3.3.3.2 as follows.

One M-package shall be placed on the shelf corresponding to each corner of the cabinet. When a cabinet has more than one section:

- In case the test room air flows from left to right, 2 additional M-packages shall be placed on the right corners of each additional shelf to the right, if not already present.
- In case the test room air flows from right to left, 2 additional M-packages shall be placed on the left corners of each additional shelf to the left, if not already present.

Figure 9 shows examples of configurations a) and b).



Key

- 1 → Configuration a) Direction of the air flow →
 ← 1 Configuration b) ← Direction of the air flow

Figure 9 — Examples of M packages positions with reference to air flow

For one or two shelves/drawers an M-package layer shall be located on the bottom layer of the bottom shelf and on the top layer of the upper shelf.

For 3 shelves/drawers, each shelf/drawer shall have one M-package layer located as follows:

- one M-package layer on the lower layer of the bottom shelf/drawer;
- one M-package layer on the upper layer of the middle shelf/drawer;
- one M-package layer on the upper layer of the top shelf/drawer.

For cabinets with more than three shelves/drawers the M-package layers shall be located as follows:

- one M-package layer on the lower layer of the bottom shelf/drawer;
- one M-package layer on the upper layer of the middle shelf/drawer. If there is an even number of shelves/drawers the lower middle shelf/drawer shall be selected as the shelf/drawer for location of M-packages;
- one M-package layer on the upper layer of the top shelf/drawer (see Figure 8).

5.3.3.4 Running in

The cabinet shall be operated at normal operating conditions with parameters preset by the manufacturer, recommended routine of defrosting shall be followed. The cabinet shall be filled with test packages and M-packages according to [5.3.3.3](#) for the tests.

After loading, the cabinet shall be operated until stable conditions as defined in [5.3.3.5](#) have been reached. During stabilization the test room shall be maintained at the desired climate class as specified in [Table 3](#), while the temperatures of the M-packages are recorded.

5.3.3.5 Stable conditions

A cabinet is considered to operate under stable conditions if, during a period of 24 h, the temperature of each M package agrees within $\pm 0,5$ °C at the corresponding points on the temperature curve.

5.3.3.6 Test conditions

5.3.3.6.1 Test period

The test shall begin after the stabilization cycle at a point half way between the start of two defrost cycles, based on the previous two defrost cycles.

The test period shall then have the following duration:

- Two sequential 24 h periods as described in [5.3.3.6.2](#) (doors/drawers opening scheme).
- During the first 24 h period the temperature and energy data shall be measured but shall not be included in the calculation of the cabinet energy consumption.
- During the second 24 h period the temperature and energy data shall be measured and shall be included in the calculation of the cabinet energy consumption.

For combined refrigerated cabinets the operating conditions are performed simultaneously on all compartments.

Multi use refrigerated cabinets shall be operated as either a refrigerator or a freezer.

When testing heavy duty cabinets at class 5 conditions, temperature test shall be carried out with doors/drawers opening scheme applied.

5.3.3.6.2 Doors/drawers opening scheme

Depending on the type of product opening/closing cycles per 24 h testing period shall be as follows.

5.3.3.6.2.1 For vertical and counter cabinet refrigerators

For each vertical section, initial opening time of doors or drawers is performed according to the pattern described in [5.3.3.6.3](#) and shall be 0,30 s per litre net volume of the vertical section with a minimum of 60 s and the maximum of 180 s. The doors/drawers opening and closing rate is 1,5 s.

NOTE In case the initial opening time is not the same for all vertical sections, the sum of the initial opening times of all vertical sections divided for the number of the sections can be applied to each vertical section.

Then for each vertical section the total opening time for doors/drawers shall be 7 s (1,5 s for opening, 4 s remains, 1,5 s for closing), six times per hour, for a total of 12 h; doors/drawers are closed for the remaining period within the 24 h test period.

5.3.3.6.2.2 For vertical and counter cabinet freezers

For each vertical section, initial opening time of doors or drawers is performed according to the pattern described in 5.3.3.6.3 and shall be 0,15 s per litre net volume of the vertical section with a minimum of 30 s and the maximum of 90 s. The doors/drawers opening and closing rate is 1,5 s.

NOTE In case the initial opening time is not the same for all vertical sections, the sum of the initial opening times of all vertical sections divided for the number of the sections can be applied to each vertical section.

Then for each vertical section:

- Step 1: the total opening time for doors/drawers shall be 7 s (1,5 s for opening, 4 s remains, 1,5 s for closing), six times per hour, for a total of 4 h;
- Step 2: doors/drawers are kept closed for 4 h;
- Step 3: step 1 is repeated;
- Step 4: doors/drawers are kept closed for the remaining time over the 24 h period.

5.3.3.6.3 General test conditions for all types of products

Opening and closing speed shall be as smooth as possible.

Each vertical section shall be opened in sequence according to the plan shown in Figure 10.

For multiple vertical sections, during the initial door opening, opening the next vertical section a maximum of 3 s before closing the previous vertical section is allowed.

Care shall be taken that the path of wires of temperature sensors does not cause abnormal moisture in the cabinet.

Following the initial door opening period the cabinet doors/drawers shall remain closed for 10 min before the following sequence of door openings shall be initiated. An example of the doors/drawers opening scheme is provided as follows:

Table 7 — 2 vertical section cabinet

	Door/drawer opening time:			
Vertical section 1	0 min	10 min	20 min	etc.
Vertical section 2	5 min	15 min	25 min	etc.

Table 8 — 3 vertical section cabinet

	Door/drawer opening time:			
Vertical section 1	0 min	10 min	20 min	etc.
Vertical section 2	3 min 20 s	13 min 20 s	23 min 20 s	etc.
Vertical section 3	6 min 40 s	16 min 40 s	26 min 40 s	etc.

Table 9 — 4 vertical section cabinet

	Door/drawer opening time:			
Vertical section 1	0 min	10 min	20 min	etc.
Vertical section 2	2 min 30 s	12 min 30 s	22 min 30 s	etc.
Vertical section 3	5 min	15 min	25 min	etc.
Vertical section 4	7 min 30 s	17 min 30 s	27 min 30 s	etc.

Table 10 — 5 vertical section cabinet

	Door/drawer opening time:			
Vertical section 1	0 min	10 min	20 min	etc.
Vertical section 2	2 min	12 min	22 min	etc.
Vertical section 3	4 min	14 min	24 min	etc.
Vertical section 4	6 min	16 min	26 min	etc.
Vertical section 5	8 min	18 min	28 min	etc.

Table 11 — 6 vertical section cabinet

	Door/drawer opening time:			
Vertical section 1	0 min	10 min	20 min	etc.
Vertical section 2	1 min 40 s	11 min 40 s	21 min 40 s	etc.
Vertical section 3	3 min 20s	13 min 20s	23 min 20s	etc.
Vertical section 4	5 min	15 min	25 min	etc.
Vertical section 5	6 min 40 s	16 min 40 s	26 min 40 s	etc.
Vertical section 6	8 min 20 s	18 min 20 s	28 min 20 s	etc.

Drawers shall be opened at 70 % + 5 % – 0 % of the depth of the drawer or at maximum opening allowed by construction if smaller than 70 %.

Doors shall be opened to 60° + 30° – 0° (from their closed position).

The sequence described above shall be followed taking into account the following:

- In each vertical section with 2 drawers, the top drawer shall be opened.
- In each vertical section with more than 2 drawers, the top drawer (to be considered as number 1) plus other odd drawers shall be simultaneously opened.
- In each vertical section with more than one door, all doors shall be simultaneously opened.

For cabinets with doors, doors in each section shall be opened simultaneously, i.e.:

- If 1 door per section — open door [as shown in [Figure 10 a](#)], section 1] according to prescribed door opening regime.
- If 2 doors per section — open doors 1 and 2 together [as shown in [Figure 10 a](#)], section 2] according to prescribed door opening regime.

For cabinets with drawers, drawers in each section shall be opened simultaneously, i.e.:

- If 1 drawer per section — open drawer 1 [as shown in [Figure 10 b](#)], section 1] according to prescribed drawer opening regime.
- If 2 drawers per section — open drawer 1 [as shown in [Figure 10 b](#)], section 2] according to prescribed drawer opening regime.
- If 3 drawers per section — open drawers 1 and 3 [as shown in [Figure 10 b](#)], section 3] according to prescribed drawer opening regime.
- If 4 drawers per section — open drawers 1 and 3 [as shown in [Figure 10 b](#)], section 4] according to prescribed drawer opening regime.
- If 5 drawers per section — open drawers 1, 3 and 5 [as shown in [Figure 10 b](#)], section 5] according to prescribed drawer opening regime.

- If 6 drawers per section — open drawers 1, 3 and 5 [as shown in [Figure 10 b](#)], section 6] according to prescribed drawer opening regime.

NOTE This testing pattern is proportionally replicated in case of products with more than 6 sections.

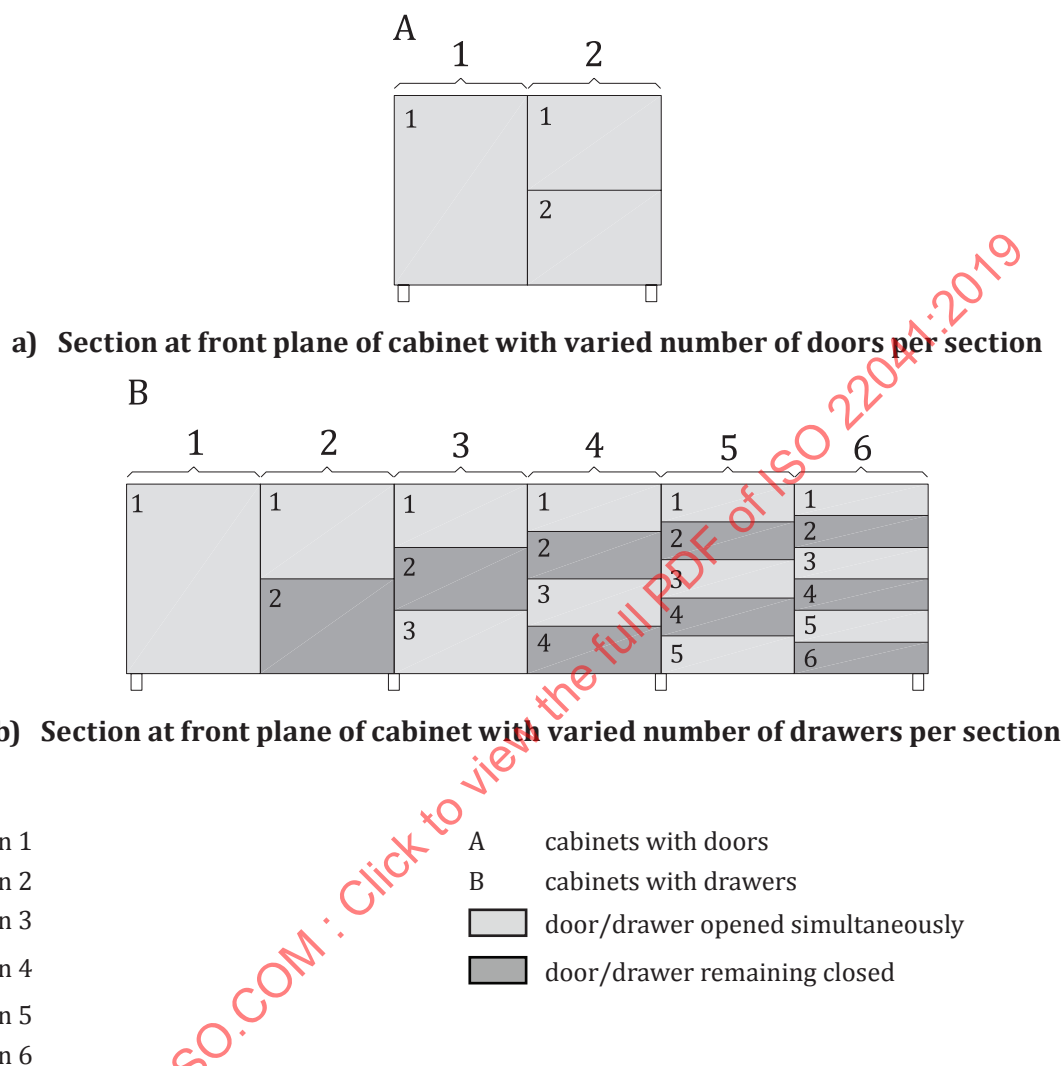


Figure 10 — Examples of door/drawers opening schemes

5.3.3.7 Lighting

If the tested cabinet is fitted with lighting, carry out the tests as follows:

- automatic lighting: works automatically;
- manual lighting (on/off possible by the user): lighting is switched on only during the door opening cycling period, including initial door opening time. Lighting is switched off when doors/drawers are closed within the remaining time of 24 h test period.

5.3.3.8 Power supply

The cabinet shall be supplied at the voltage and frequency marked on the rating plate. In case a range of voltage or frequency are indicated, the cabinet is supplied at the conditions giving the highest energy consumption. 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.

5.3.3.9 Testing several cabinets in the same room

If more than one cabinet is being tested in the same room, appropriate arrangements, such as the use of partitions, shall be made in order to ensure that the conditions surrounding each cabinet are in accordance with the test requirements specified in [5.3.2.3](#).

5.3.4 Temperature test

5.3.4.1 Test conditions

The cabinet shall be located and loaded in accordance with [5.3.2](#) and [5.3.3](#), 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](#)), operated to stable conditions defined in [5.3.3.5](#) and then operated for the test period during which measurements shall be recorded. Lighting, if any, shall be manipulated according to [5.3.3.7](#).

All temperatures are recorded at a maximum interval of 60 s. Measured temperature values shall be rounded to one decimal place.

5.3.4.2 Temperature curves of M-packages

From the recorded temperatures of all M-packages, the following curves shall be plotted as a function of time:

- a) the temperature of the warmest M-package (i.e. the one with the highest peak temperature) (see [Figure 11](#));
- b) the temperature of the coldest M-package (i.e. the one with the lowest minimum temperature) (see [Figure 11](#));

All other M-package temperatures shall be available for reference if required.

In the case of cabinets with multiple temperature classes, curves a) and b), as indicated in [Figure 11](#) shall be prepared separately for each temperature class.