
Refrigerated display cabinets —
Part 2:
Classification, requirements and test
conditions

Meubles frigorifiques de vente —

Partie 2: Classification, exigences et méthodes d'essai



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Foreword

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

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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

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

ISO 23953-2 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 44, *Household refrigerating appliances and commercial refrigeration equipment*, in collaboration with Technical Committee ISO/TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 7, *Testing and rating of commercial refrigerated display cabinets*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO 23953-2, together with the first edition of ISO 23953-1, cancels and replaces ISO 1992-1:1974, ISO 1992-4:1974, ISO 1992-5:1974, ISO 1992-6:1974, ISO 5160-1:1979 and ISO 5160-2:1980, of which it constitutes a technical revision.

ISO 23953 consists of the following parts, under the general title *Refrigerated display cabinets*:

- *Part 1: Vocabulary*
- *Part 2: Classification, requirements and test conditions*

Refrigerated display cabinets —

Part 2: Classification, requirements and test conditions

1 Scope

This part of ISO 23953 specifies requirements for the construction, characteristics and performance of refrigerated display cabinets used in the sale and display of foodstuffs. It specifies test conditions and methods for checking that the requirements have been satisfied, as well as classification of the cabinets, their marking and the list of their characteristics to be declared by the manufacturer. It is not applicable to refrigerated vending machines or cabinets intended for use in catering or similar non-retail applications; nor does it cover the choice of the types of foodstuffs chosen to be displayed in the cabinets.

2 Normative references

The following referenced documents are indispensable for the application 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 system*

ISO 9050, *Glass in building — Determination of light transmittance, solar direct transmittance, total solar energy transmittance and ultraviolet transmittance, and related glazing factors*

ISO 23953-1:2005, *Refrigerated display cabinets — Part 1: Vocabulary*

IEC 60335-2:89, *Safety of household and similar electrical appliance — Part 2: Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit*

EN 378-2, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 2: Design, construction, testing, marking and documentation*

EN 60335-1, *Safety of household and similar electrical appliances — Part 1: General requirements*

3 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the terms and definitions given in ISO 23953-1 and the following symbols and abbreviated terms apply.

3.1 General

- t_{run} running time — time during which compressor is running (or solenoid valve is open) or secondary refrigerant is circulating (or solenoid valve is open), within 24 h
- t_{run75} 75 % of the running time between defrosts, excluding the time just after defrost, $0,75 t_{run}$
- t_{stop} stopping time — time during which compressor is not running (or solenoid valve is closed) or secondary refrigerant is not circulating (or solenoid valve is closed), within 24 h and excluding defrost time
- t_{defft} defrost time — time during defrost during which compressor is not running (or solenoid valve is closed) or secondary refrigerant is generally not circulating, within 24 h, but not considered as stopping time
- q_m mass flow rate of liquid refrigerant or secondary refrigerant in kilograms per second
- Δt time between two consecutive measuring samples
- N_{max} number of measuring samples in 24 hours
- N_{75} number of measuring samples during 75 % of the running time period between 2 defrosts, excluding time just after defrost
- n_{defft} number of defrosts during 24 h
- DEC direct electrical energy consumption, in kilowatt hours per 24 h period
- REC_{RC} refrigeration electrical energy consumption, in kilowatt hours per 2 h period, for remote cabinet for compression-type refrigerating system
- REC_{RI} refrigeration electrical energy consumption, in kilowatt hours per 2 h period, for remote cabinet for indirect refrigerating system
- TEC total energy consumption in kilowatt hours per 24 h period
- t_{rr} relative or percentage running time:

$$t_{rr} = \frac{t_{run}}{t_{run} + t_{stop}} = \frac{t_{run}}{24 - t_{defft}}$$

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

- Φ_n instant heat extraction rate

3.2 Compression-type refrigeration systems

h_8, h_4	specific enthalpy in kilojoules per kilogram, where state at point 8 corresponds to refrigerant outlet, and state at point 4 to refrigerant inlet, of cabinet
θ_7	refrigerant mean temperature at evaporator outlet
θ_{mrun}	arithmetic average of evaporator-saturated temperature obtained from pressure p_7 by referring to table of saturation properties for refrigerant in use — during t_{run} , in degrees Celsius
θ_{min}	arithmetic average of evaporator-saturated temperature obtained from pressure p_7 by referring to table of saturation properties for refrigerant in use — during the last 10 % of all running periods, in degrees Celsius
T_{mrun}	$= \theta_{mrun} + 273,18$

3.3 Indirect refrigeration-type systems

θ_i	secondary refrigerant temperature at cabinet inlet, in degrees Celsius
θ_o	secondary refrigerant temperature at cabinet outlet, in degrees Celsius
θ	secondary refrigerant median temperature, in degrees Celsius $(\theta_i + \theta_o)/2$
θ_{mrun}	arithmetic average of the secondary refrigerant median temperature (θ) during t_{run} , in degrees Celsius
θ_{min}	arithmetic average of the secondary refrigerant median temperature (θ) during last 10 % of all running periods, in degrees Celsius
q_{mrun}	arithmetic average of the secondary refrigerant mass flow during t_{run} , in kilograms per second
c_i	specific heat of secondary refrigerant, in kilojoules per kilogram per degree Celsius at cabinet inlet
c_o	specific heat of the secondary refrigerant, in kilojoules per kilogram per degree Celsius, at cabinet outlet
$p_{irun} - p_{orun}$	pressure drop between inlet and outlet of cabinet during t_{run} , in newtons per square metre
PEC	pumping electrical energy consumption
v	specific volume of secondary refrigerant, in cubic metres per kilogram (simplification: $v = \text{const.} = 0,001 \text{ m}^3/\text{kg}$)

4 Requirements

4.1 Construction

4.1.1 General

4.1.1.1 Strength and rigidity

The cabinet and its parts shall be constructed with adequate strength and rigidity for normal conditions of handling, transport and use and attention shall be given to the following:

- a) interior fittings, including shelves, baskets, rails, etc. and their supports, shall be sufficiently strong for the duty required;
- b) where sliding shelves, baskets, trays or drawers are fitted they shall retain their shape and ease of movement when fully loaded;
- c) any fittings which are provided with stops to prevent accidental removal shall be self-supporting when fully loaded and withdrawn to the limit of the stops.
- d) stops.

4.1.1.2 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 sufficient free length and/or vibration eliminators shall be provided to prevent failure due to fatigue. Where necessary, pipes and valves shall be adequately thermally insulated.

4.1.1.3 Condensate drainage

Where drains, drip trays or evaporation receptacles are fitted, they shall have ample capacity and shall be easily accessible and cleanable.

Any condensate or defrost water receptacle, or group of receptacles, requiring to be emptied manually shall have a capacity equivalent to at least 48 h of normal operation in the appropriate climate class for which the cabinet is intended.

4.1.1.4 Closed refrigerated cabinets (self-service type)

Closed refrigerated cabinets shall meet certain special requirements as follows.

Self-closing doors shall be opened by different angles up to and including 80° and shall from these different positions automatically assume their original position and close tight in accordance with 5.2.1.

On low-temperature applications, transparent doors and lids shall be condensate-free at the climate class specified by the manufacturer. Glass doors shall incorporate sufficient heating to the internal surface to provide moisture dispersal for clear vision after closing. Horizontal sliding lids are exempt from this requirement.

Door fasteners and hinges under normal conditions of use shall be smooth and positive in action and designed to function properly without undue wear.

When any doors or 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.

The doors or 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.

4.1.1.5 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.

4.1.1.6 Sneeze guard

The front façade constitutes a guard against risks of contamination emanating from consumers through handling, coughing, etc. in case of display and sale of unpacked foodstuffs.

For this, the sum of vertical dimension *A* and horizontal dimension *B* as shown in Figure 1 shall be not less than 1 500 mm.

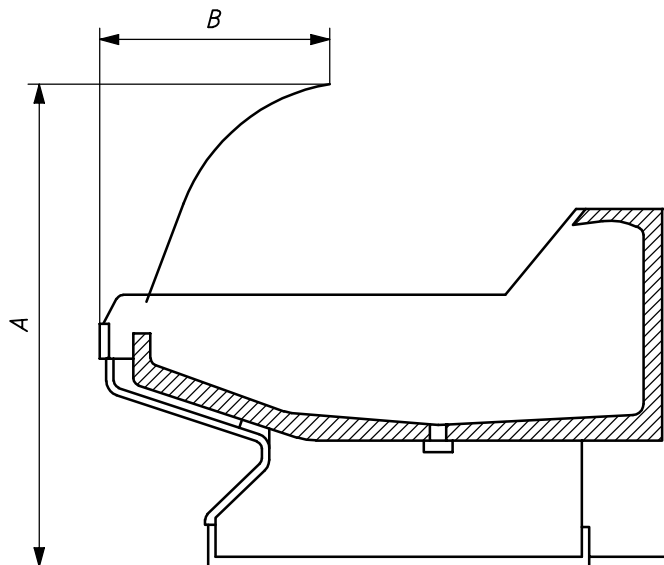


Figure 1 — Dimensions for sneeze guard

4.1.2 Materials

4.1.2.1 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.

4.1.2.2 Wear resistance

Internal and external finishes shall be resistant to wear and capable of being cleaned effectively and hygienically. Finishes shall not crack, chip, flake, rub off or soften under normal conditions of use or during cleaning.

4.1.2.3 Corrosion resistance

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

4.1.3 Thermal insulation

4.1.3.1 Efficiency

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 (see 4.2.4).

4.1.3.2 Vapour barrier

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

4.1.3.3 Containment of insulation material

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.

4.1.4 Refrigerating system

4.1.4.1 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 will be subjected when the cabinet is in operation or at rest.

For refrigerated display cabinets with integral condensing unit or components thereof which are charged with refrigerant prior to transportation, the maximum ambient temperature during transit shall be taken into account. All refrigerant containing components shall be in accordance with EN 378-2.

4.1.4.2 Condensation

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

4.1.4.3 System protection

For cabinets fitted with doors or lids, the refrigerating system shall suffer no damage if any door or lid in the cabinet is left open while the cabinet is operating in an ambient temperature corresponding to the climate class (see Table 3) for which the cabinet is intended.

When the door or 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.

4.1.4.4 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 or secondary refrigerant, due to their toxicity, flammability etc. Guidance on this point is available in EN 378-1.

4.1.5 Electrical components

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

4.1.6 Temperature display

The cabinets shall incorporate a temperature display instrument showing the air temperature in the refrigerated display cabinets to provide an indication of the operation and functioning of refrigerating equipment and information on its operating state.

NOTE As a rule, measured air temperature is not identical with foodstuff temperature in refrigerated display cabinets.

4.1.6.1 Temperature-measuring instrument

Suitable temperature-measuring instruments shall be used, i.e. those that fulfil 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 –25 °C to +15 °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.

NOTE The t_{90} time is the 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).

4.1.6.2 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.

NOTE 1 The temperature sensor of a thermometer is considered to be “readily accessible” if it can be reached directly for examination. It could be necessary to remove access panel(s) to carry out replacement.

NOTE 2 For cabinets with natural convection cooling, the positioning of the temperature sensor in a guide tube is also considered to be “readily accessible” if the sensor can be 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.

The temperature sensor's location is defined as part of the temperature test of the refrigerated display cabinet. During the temperature test, air temperatures at the declared sensor location shall be measured and these values noted in the test report.

The air return temperature shall be displayed. The temperature sensor shall be mounted to indicate the temperature at the air-return side at the level of the clearly marked load limit line, except for vertical cabinets for chilled foodstuffs, vertical closed cabinets for chilled and frozen foodstuffs and cabinets with natural convection cooling.

For vertical cabinets (semi-vertical, multi-deck, roll-in) for chilled foodstuffs and vertical closed cabinets for chilled and frozen foodstuffs, the temperature sensor shall be mounted to indicate the temperature at one of the following locations.

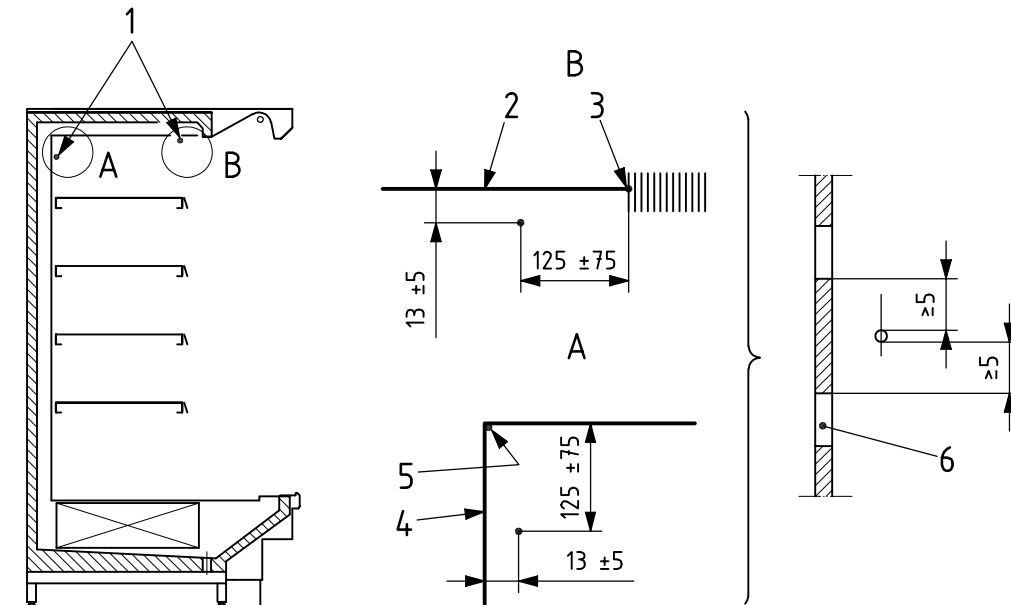
- a) At the air return, at a free place between physical air return and front area of the heat exchanger.
- b) At the location on the back wall panel or on the ceiling panel of the cabinet to the right or to the left of the cabinet horizontally (500 ± 200) mm away from the end of the cabinet (see Figure 2). It shall be fixed (13 ± 5) mm away from the panel (not blocking a hole) and positioned at (125 ± 75) mm away from the reference point which is
 - the air curtain outlet for ceiling mounting, or
 - for back-wall mounting, the ceiling back wall corner or the lower edge of the mirror (if present).

For cabinets with natural convection cooling, the manufacturer defines the temperature sensor location.

NOTE 3 For an electronic controller, it is possible to display a calculated temperature.

NOTE 4 For recording and display of temperatures, one or two temperature sensors can be used. The temperature sensor can be the same as those used for controlling the refrigeration. An alarm can be activated in case of error. However, this option is not in accordance with the requirements of EN 12830.

Dimensions in millimetres



Key

- 1 temperature sensor
- 2 ceiling
- 3 reference point for ceiling mounting: inner side of air curtain outlet
- 4 back wall
- 5 reference point for back wall mounting: ceiling back wall corner or lower edge of mirror
- 6 ceiling or back wall with holes

Figure 2 — Location of temperature sensor of vertical chilled cabinet when not located at air return

4.1.6.3 Number of temperature-measuring instruments

When temperature-measuring instruments are employed in refrigerated display cabinets:

- one temperature-measuring instrument shall be employed for each refrigerated display cabinet with its own refrigerating circuit;
- in the case of several refrigerated display cabinets with a common refrigerating circuit operating in one temperature class, a minimum of one temperature-measuring instrument shall be employed for maximum two refrigerated display cabinets with a total length of maximum 3,75 m;
- in the case of several refrigerated display cabinets with a common refrigerating circuit working in different temperature classes, the above requirement shall be observed, but with separate temperature-measuring instruments employed for each temperature class.

4.2 Operating characteristics

4.2.1 Absence of odour and taste

The absence of odour and taste is not compulsory. An optional test method of is given in Annex D.

4.2.2 Classification according to temperature

The performance of cabinets 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 5.3.3.

NOTE Annex C compares laboratory and store condition.

Table 1 — M-package temperature classes

Class	Highest temperature, θ_{ah} , of warmest M-package less than or equal to (see Figure 25)	Lowest temperature, θ_b , of coldest M-package greater than or equal to (see Figure 25)	Lowest temperature, θ_{al} , of warmest M-package less than or equal to (see Figure 25)
	°C		
L1	– 15	—	– 18
L2	– 12	—	– 18
L3	– 12	—	– 15
M1	+ 5	– 1	—
M2	+ 7	– 1	—
H1	+ 10	+ 1	—
H2	+ 10	– 1	—
S	Special classification		

4.2.3 Defrosting

The accumulation of ice, frost or snow on surfaces within the refrigerated space (excluding the surfaces of the test packages), as well as the accumulation of drained defrost water, shall not occur, as it would impair the performance of cabinets other than those which are intended to be defrosted manually. This shall be verified according to the conditions and test methods specified in 5.3.3.3.

The proposed defrosting procedures (automatic or manual) shall not affect the temperature requirements.

For cabinets or parts of cabinets with manual defrosting, the manufacturer shall supply all necessary instructions for the correct operation of the defrosting system.

4.2.4 Water vapour condensation

The performance of cabinets 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 5.3.4.

4.2.5 Energy consumption

The heat extraction rate and the energy consumption shall be stated by the manufacturer.

The direct electrical energy consumption (DEC) and, when the condensing unit is remote from the cabinet, the refrigeration electrical energy consumption (REC) and total energy consumption (TEC) shall be measured and calculated according to the conditions and the test methods specified in 5.3.5 and 5.3.6.

5 Tests

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.

Table 2 lists the tests and inspections. Cabinets shall comply with the requirements specified in this part of ISO 23953 using the appropriate test method.

Table 2 — Test summary

Tests and inspections	Requirement clause in this part of ISO 23953	Test method	
Seal test	4.1	5.2.1	Outside test room (see 5.2)
Physical dimensions of sneeze guard	4.1.1.6	5.2.2	
Absence of odour and taste (not compulsory)	—	Annex D	
Temperature	4.2.2	5.3.3	Inside test room (see 5.3)
Defrosting	4.2.3	5.3.3	
Water vapour condensation	4.2.4	5.3.4	
Energy consumption	4.2.5	5.3.5 and 5.3.6	

5.2 Tests outside test room

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.

5.2.1 Seal test for doors and lids

The effectiveness of doors or lids provided to ensure a seal shall be tested as follows (with the cabinet 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 door or lid closed normally on it the strip of paper shall not slide freely.

NOTE 1 Attention is drawn to the fact that some cabinets having doors provided to ensure an air seal 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 cabinet may be 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 cabinet closed and lighted from the inside.

5.2.2 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.

For cabinets having detachable ends, overall dimensions are given with and without ends. If the cabinet includes jacks or other components for adjustment of height, the height defined shall be the minimum height necessary at installation of the cabinet.

When measuring the net volume parts necessary for the proper functioning of the cabinet, including shelves used in the calculation of the refrigerated shelf area, these shall be fitted as intended and the volume representing the space occupied by these parts deducted.

The total display (TDA) area shall be calculated according to Annex A. The visibility of foodstuffs (VPA) shall be calculated according to Annex B.

5.3 Tests inside test room

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

- temperature and defrosting;
- water vapour condensation;
- electrical energy consumption;
- heat extraction rate.

These measurements should be made simultaneously.

5.3.1 General conditions

In the following, general testing conditions which are common for all tests specified in 5.3.3 to 5.3.6 carried out inside the test room are defined. These conditions concern the test room, the test and M-packages, and the measuring instruments.

5.3.1.1 Test room — General 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 cabinet to be tested and on the location of the display opening of the cabinet (see 5.3.2.1).

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 ($\lambda = 0,03 \text{ W/m } ^\circ\text{C}$) 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.

Fluorescent 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/1 m.

The walls, ceilings and any partitions of rooms intended for the testing of refrigerated display cabinets 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.

5.3.1.2 Test room (empty) — Thermal and air flow characteristics

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

- with test room empty and with lighting switched on,
- in a test-room climate class 3 (see Table 3),
- measuring the velocity, temperature and relative humidity of the air at different points of 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 this 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 m² 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 ± 3 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.

5.3.1.3 Test room climate definition

5.3.1.3.1 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 ± 1 °C of the temperature and ± 5 units of the relative humidity percentage figures at the specified climate measuring point(s) (see 5.3.1.3.2). The exception to this is test-room climate class 3, for which the tolerance of the relative humidity is instead ± 3 units.

Table 3 — Climate classes

Test room climate class	Dry bulb temperature	Relative humidity	Dew point	Water vapour mass in dry air
	°C	%	°C	g/kg
0	20	50	9,3	7,3
1	16	80	12,6	9,1
2	22	65	15,2	10,8
3	25	60	16,7	12,0
4	30	55	20,0	14,8
6	27	70	21,1	15,8
5	40	40	23,9	18,8
7	35	75	30,0	27,3
8	23,9	55	14,3	10,2

NOTE The water vapour mass in dry air is one of the main points influencing the performance and the energy consumption of the cabinets. See also Annex D to compare lab and store conditions.

5.3.1.3.2 Climate measuring point

The point for measurement of ambient temperature and relative humidity shall be midway along the length of the cabinet and in accordance with Figures 3 to 6.

In the case of typical island cabinets, temperatures shall be taken at both sides (see Figure 4).

For plug-in cabinets, the warm condenser air flow shall be prevented from influencing the temperature at the measuring point by air deflectors or other suitable means.

Dimensions in millimetres

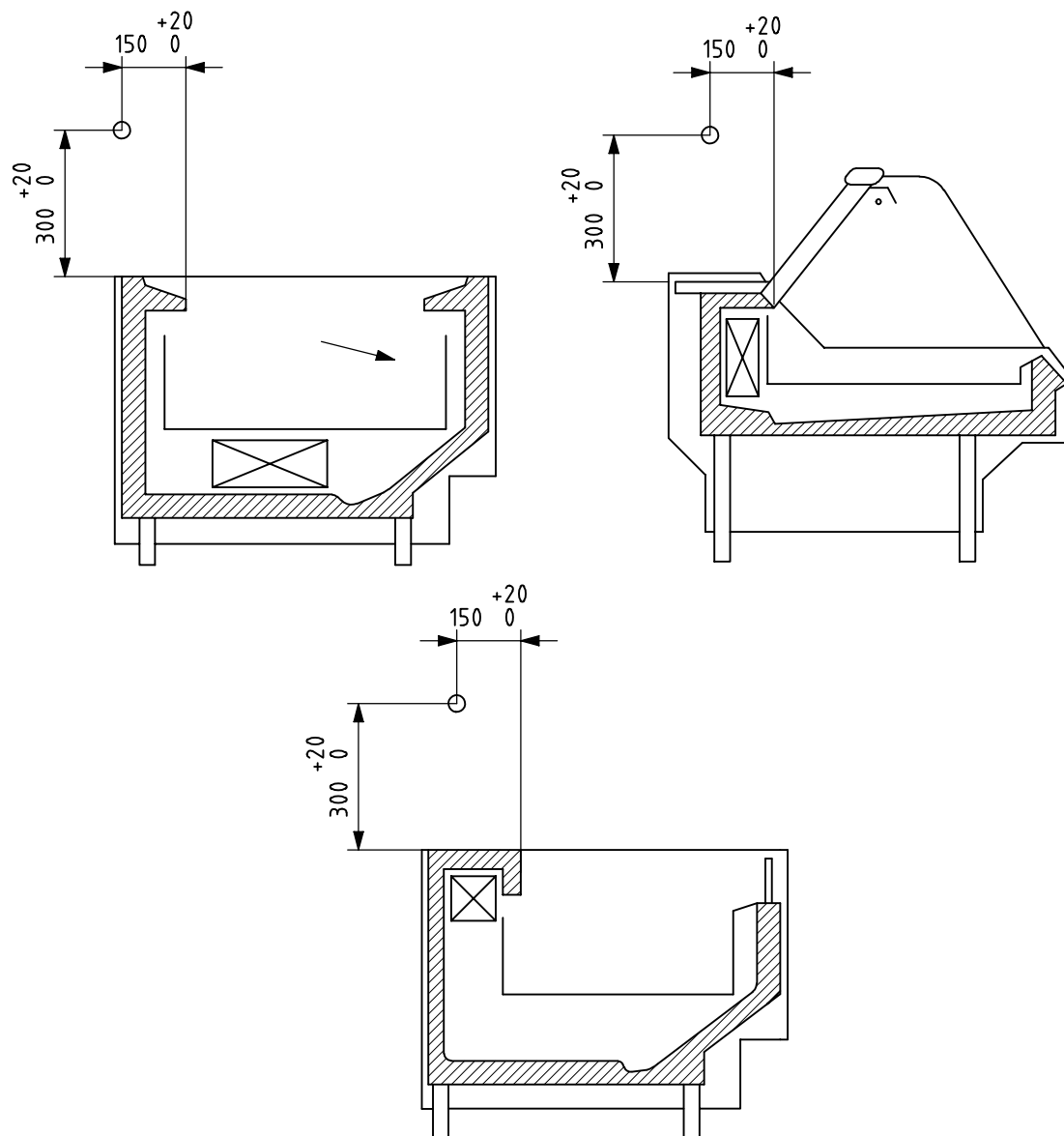


Figure 3 — Climate measuring point for two typical examples of horizontal open, wall site cabinets, and one example of serve-over counter cabinet

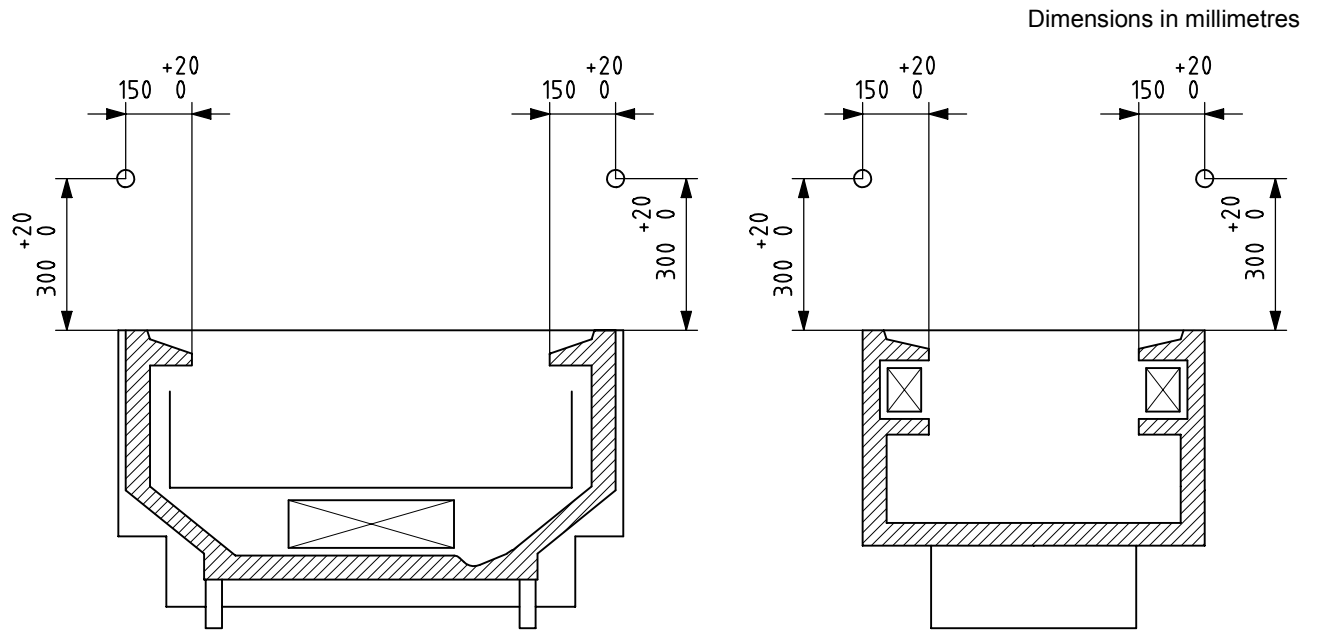


Figure 4 — Climate measuring point for two typical examples of horizontal, open, island site cabinets

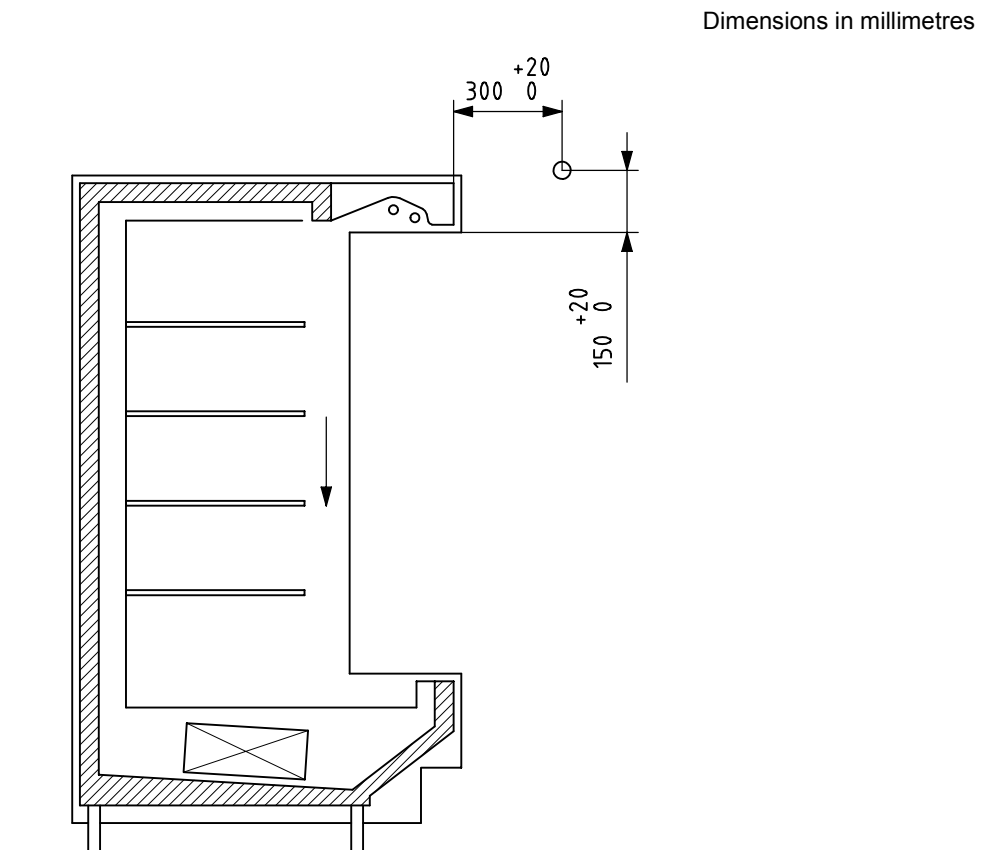


Figure 5 — Climate measuring points for one typical example of vertical multi-deck cabinet

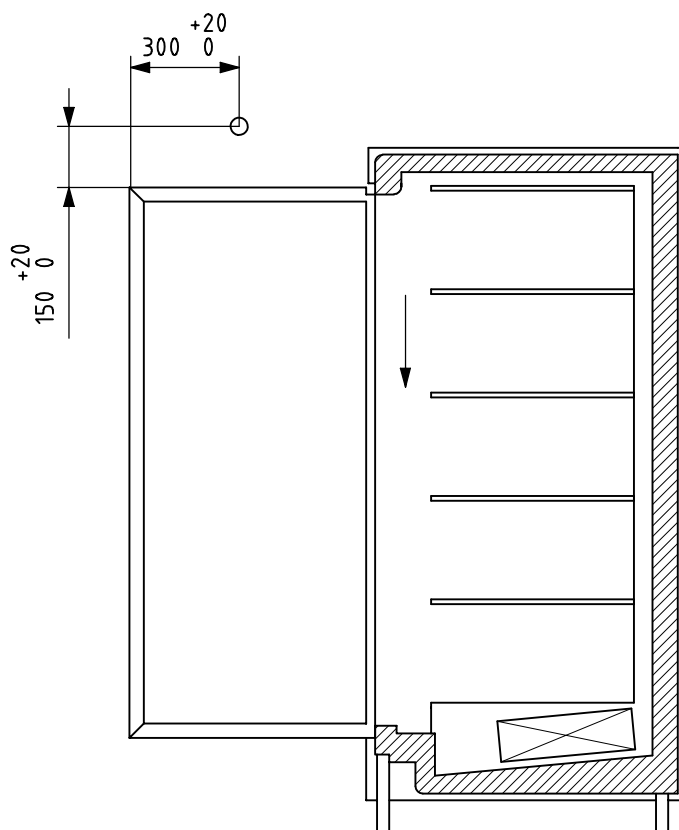


Figure 6 — Climate measuring point for one typical example of vertical glass door cabinet

5.3.1.4 Test packages and life-time

When tests are carried out, test packages in the form of right 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
50 × 100 × 200	1 000
The following packages may be used as fillers to complete the cabinet loading:	
25 × 100 × 200	500
37,5 × 100 × 200	750

Due to the frequency of use and to the loading pressure, the package 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 tolerances, it shall be replaced.

- a) Loss of mass: – 5 %.
- b) On the wrapper: no 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 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.

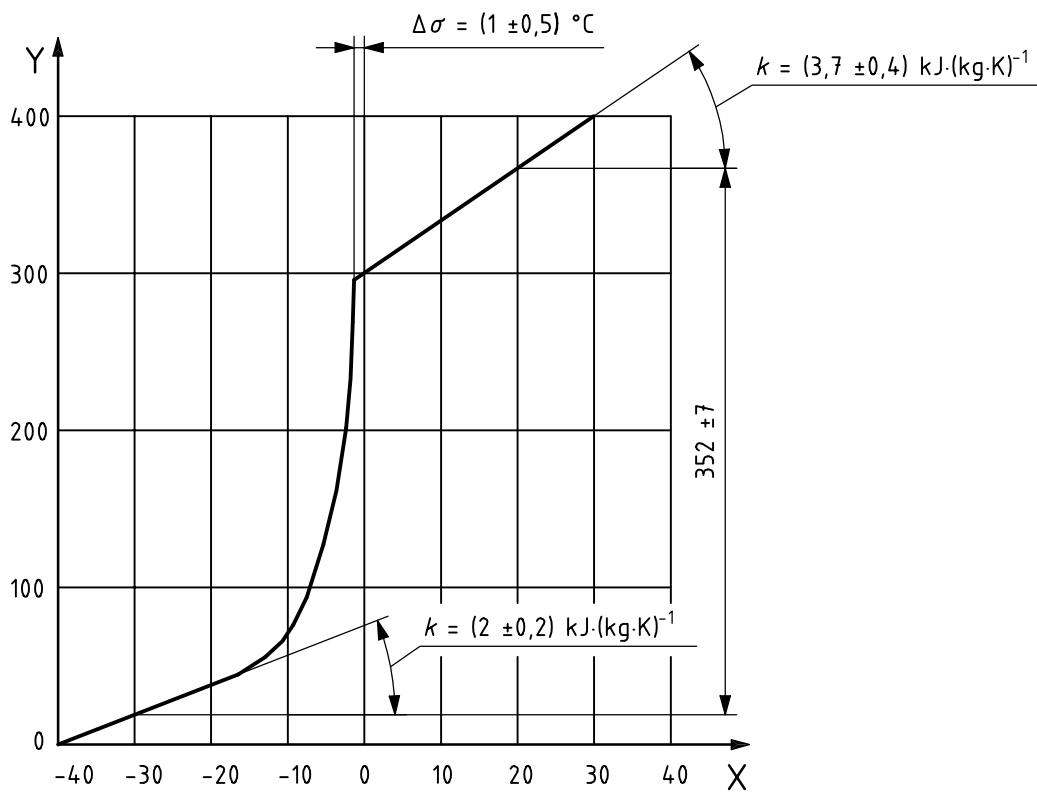
The freezing point of this material is -1 °C (its thermal characteristics corresponding to those of lean beef). The enthalpy value of 285 kJ/kg shall correspond to the temperature $(-1 \pm 0,5)$ °C (see Figure 7, Tables 5 and 6).

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

Wrapper: a sheet of plastic or any other suitable material of such nature that exchange of moisture with the ambient medium is negligible: the surface emissivity shall be equal to $0,9 \pm 0,05$ at 25 °C.

A laminated sheet should be used, consisting of a layer of high-pressure polyethylene, easily sealed, 120 μm thick, together with an external sheet of polyterephthalate approximately 12,5 μm thick, the two layers being bonded together. 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

Figure 7 — 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
-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

5.3.1.5 M-packages and life-time

Some of the 500 g packages (50 mm × 100 mm × 100 mm) specified in 5.3.1.4 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. 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 8).

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 5.3.1.4. The checking results shall be recorded for each lot of M-packages. When a M-package is found to exceed one of the tolerances, it shall be replaced.

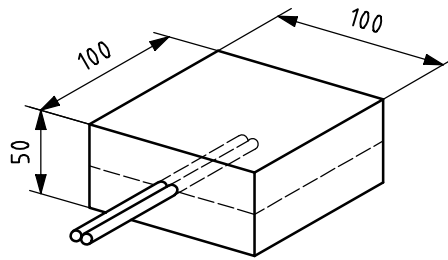


Figure 8 — M-Package

5.3.1.6 Instruments, measuring equipment and measuring accuracy

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

- Temperature measurements shall be made to an accuracy of $\pm 0,5$ °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).

Specially for the test of a cabinet intended for connection to an indirect type refrigerating system, secondary refrigerant temperature measurements shall be made to an accuracy of $\pm 0,1$ °C (see 5.3.6.2.2).

- Illumination flux per square metre shall be measured to an accuracy of ± 10 %.
- Pressures shall be measured to an accuracy of ± 1 %.
- Relative humidity shall be measured to an accuracy of ± 3 units of the percentage figure.
- Electrical energy consumption shall be measured to an accuracy of ± 2 % (see 5.3.5).
- Time interval measurements shall be made to an accuracy of ± 1 % or better. All the temperatures are checked every 60 s.

The time interval for the measurements of refrigerant mass flow rate, inlet/outlet temperature and inlet and suction pressure shall be 20 s (see 5.3.6.2).

- Air velocity shall be measured using a laboratory-type instrument with an accuracy 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.
- Mass flow rate shall be measured to an accuracy of ± 1 % (see 5.3.6).

5.3.2 Preparation of test cabinet and general test procedures

5.3.2.1 Cabinet selection, installation and positioning within the test room

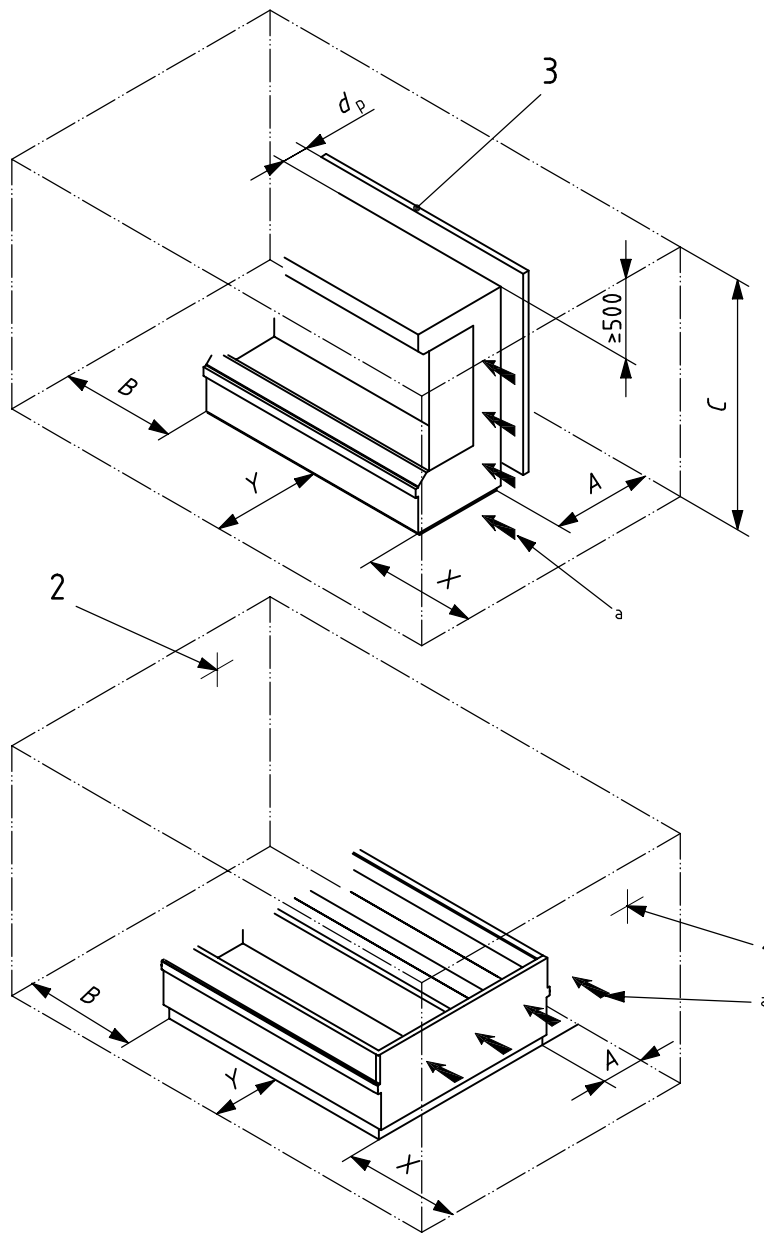
Each refrigerated display cabinet intended to be tested, unless a prototype, shall be selected from stock or routine production and shall be representative as to construction and adjustment.

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.

The cabinet shall be located as follows (see Figure 9):

- $X \geq 1,5$ m and $B \geq 0,5$ m for vertical glass door cabinets of length less than 1,6 m and horizontal closed cabinets;
- $X = 2$ m and $B \geq 1$ m for all other cabinets;
- $Y \geq 1,5$ m for open vertical cabinets and combined cabinets with open top, defined as cabinet families VC1, VC2, VC3, VF1, VF2, YC1, YC2, YF1, YF2, YM5, YM6 (see ISO 23953-1:2005, Annex A);
- $Y \geq 0,8$ m for horizontal cabinets, vertical cabinets with glass doors and combined cabinets with glass door top, defined as cabinet families HC1, HC2, HC3, HC4, HC5, HC6, HF1, HF3, HF4, HF5, HF6, VC4, VF4, YC3, YC4, YF3, YF4, YM7, YM8 (see ISO 23953-1:2005, Annex A);
- $A \geq 0,8$ m
 $A = Y$ should be used when $A \geq 1,5$ m;
- $C \geq$ height of cabinet + 0,5 m (for vertical cabinets).

For cabinets intended to be placed against a wall, and in order to check the running of cabinets with incorporated condensing unit correctly according to 5.3.2 or the water vapour condensation according to 5.3.4, a vertical partition shall be placed either against the rear of the cabinet or at a distance d_p from the rear as specified by the manufacturer (see Figure 9).



Key

- d_p partition distance specified by the manufacturer
- 1 technical side wall — test room air discharge
- 2 technical side wall — test room air return
- 3 vertical partition for wall site cabinet with same length and height as cabinet
- a Air currents parallel to the plane of the opening (in longitudinal direction).

Figure 9 — Cabinet location within test room

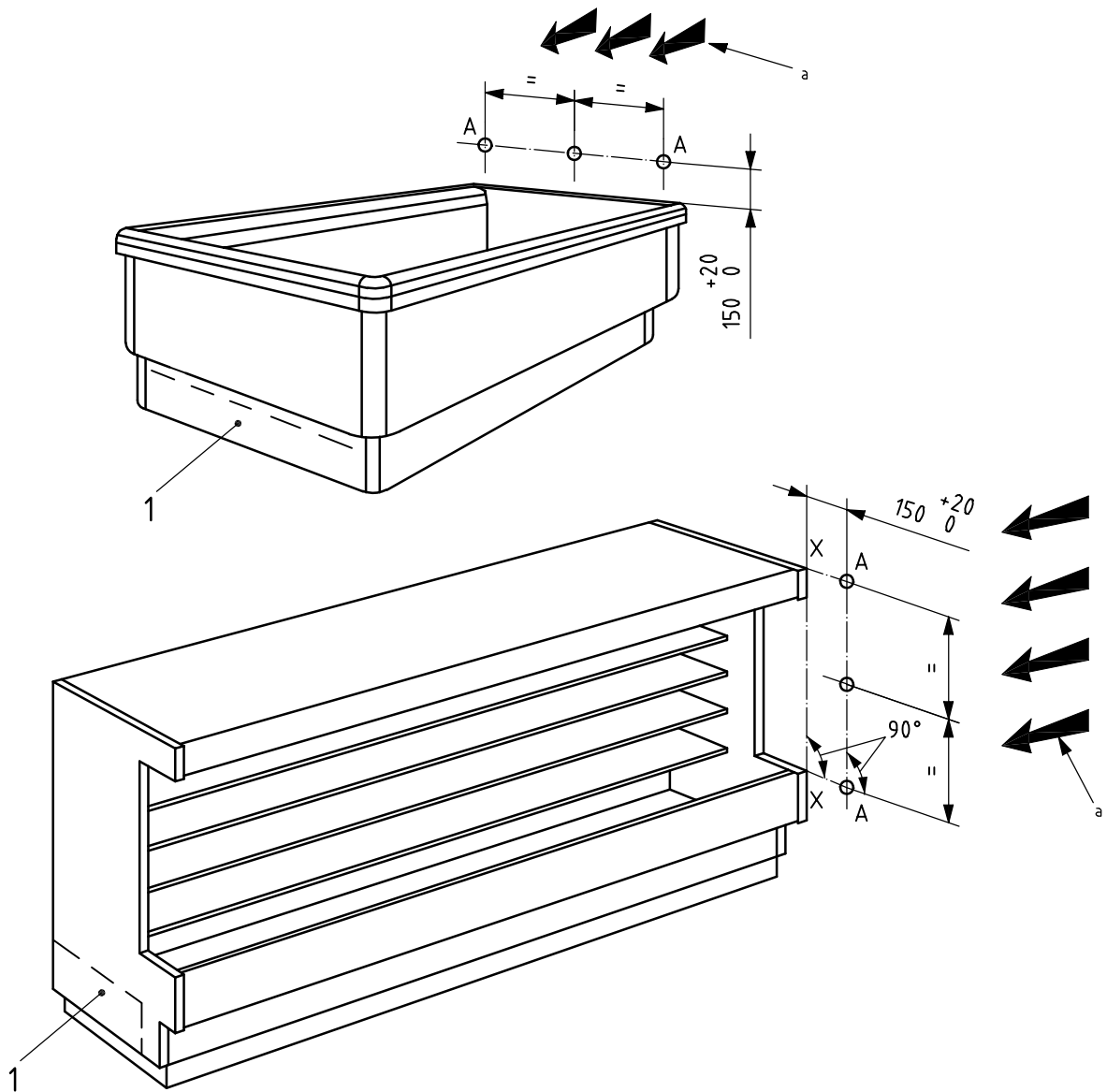
5.3.2.2 Air movement

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. 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 10 shall be 0,2 m/s.

For closed refrigerated cabinets, the direction of air flow shall be such that the air enters the cabinet when the door(s) is (are) open.

Test room air movement shall be checked during the test in order to ensure that the test room is running correctly. The method of checking is left to the discretion of testing authority.

Dimensions in millimetres



Key

A-A line for the measurement of the air velocity

X-X reference line joining the end of the upper part and the end of the lower part of the cabinet

1 possible location of condensing unit

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

Figure 10 — Air movement

5.3.2.3 Loading the cabinet

5.3.2.3.1 General

The cabinet shall be loaded with test packages and M-packages (see 5.3.1.4 and 5.3.1.5) up to the load limit, as illustrated in Figures 11 to 24. These packages shall have been brought previously to a temperature equal to that expected during the test.

For cabinets intended to be switched off at night, test packages shall be introduced during the running-in period (see also 5.3.2.4) at a temperature equal to the lower limit of the M-package temperature class with a tolerance (0 °C, + 2 °C).

1 000 g packages and 500 g packages should be used.

To complete the loading, use test packages of the following sizes as fillers:

- 25 mm × 100 mm × 200 mm;
- 37,5 mm × 100 mm × 200 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 in the direction of the airflow in the cabinet.

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

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 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.

For roll-in cabinets or multi-deck cabinets with a loading height above 500 mm (see Figure 23), some wood loading may be used. The thickness of each layer is not specified.

EXAMPLE Varnished pieces of exterior grade beech plywood with good water resistance, 200 mm by 50 mm by the depth of loading.

Metallic grids can be used to support the test package loading on M-package rows and the adjacent ones.

5.3.2.3.2 Loading heights

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

- a) For horizontal cabinets, the loading height shall be equal to the height defined by the load limit, with a tolerance of $\begin{matrix} 0 \\ -15 \end{matrix}$ mm (see Figure 11 and Figures 13 to 18).
- b) For open vertical cabinets with a minimum of two superimposed refrigerated shelves, the loading height shall be equal the free height between the refrigerated shelves minus 25 mm, with a tolerance of $\begin{matrix} 0 \\ -25 \end{matrix}$ mm (see Figures 19 to 21 and Figure 23).
- c) For all open cabinets, intended for sensitive foodstuffs not suitable for multiple layer stacking, the loading shall be equal to 100 mm (for an example, see Figures 12 and 22).

- d) For closed vertical cabinets, the loading height shall be equal to half of the maximum free height above the refrigerated shelf, with a tolerance of $^{+25}_0$ mm (see Figure 24).

5.3.2.3.3 M-package locations

The M-packages shall be placed at the position shown on the cabinet drawings (see Figures 11 to 24).

5.3.2.3.3.1 Longitudinal section

For cabinet 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 cabinet end wall.

For cabinet lengths of more than 700 mm, a third transverse section shall be placed midway along the cabinet length, with a tolerance of 75 mm. When the cabinet 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.

5.3.2.3.3.2 Cross-section

For refrigerated shelf 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 as follows:

- a) for island site cabinets, at 150 mm from the loading front (see Figures 15 and 16);
- b) for other cabinets, at 50 mm from the back panel (see Figures 11 to 14 and 17 to 24)

For refrigerated shelf depths of more than 550 mm, a third longitudinal section shall be placed midway across the shelf depth with a tolerance of

- $d/2$ mm from the air-discharge side for cabinets with forced-air cooling (see Figures 11 to 13, Figure 15 and Figures 19 to 24), or
- $d/2 \pm 50$ mm for natural-convection-cooled cabinets equipped with two evaporators or having a symmetrical layout (see Figures 16 to 18), or
- $d/2$ mm from the evaporator side for other natural-convection-cooled cabinets (see Figure 14).

In the height, for the base deck and each refrigerated shelf, M-packages shall be located into the lower and upper loading layers. When the distance between the axes of M-packages is more than 400 mm, another M-package layer shall be introduced (see Figures 20, 21 and 23).

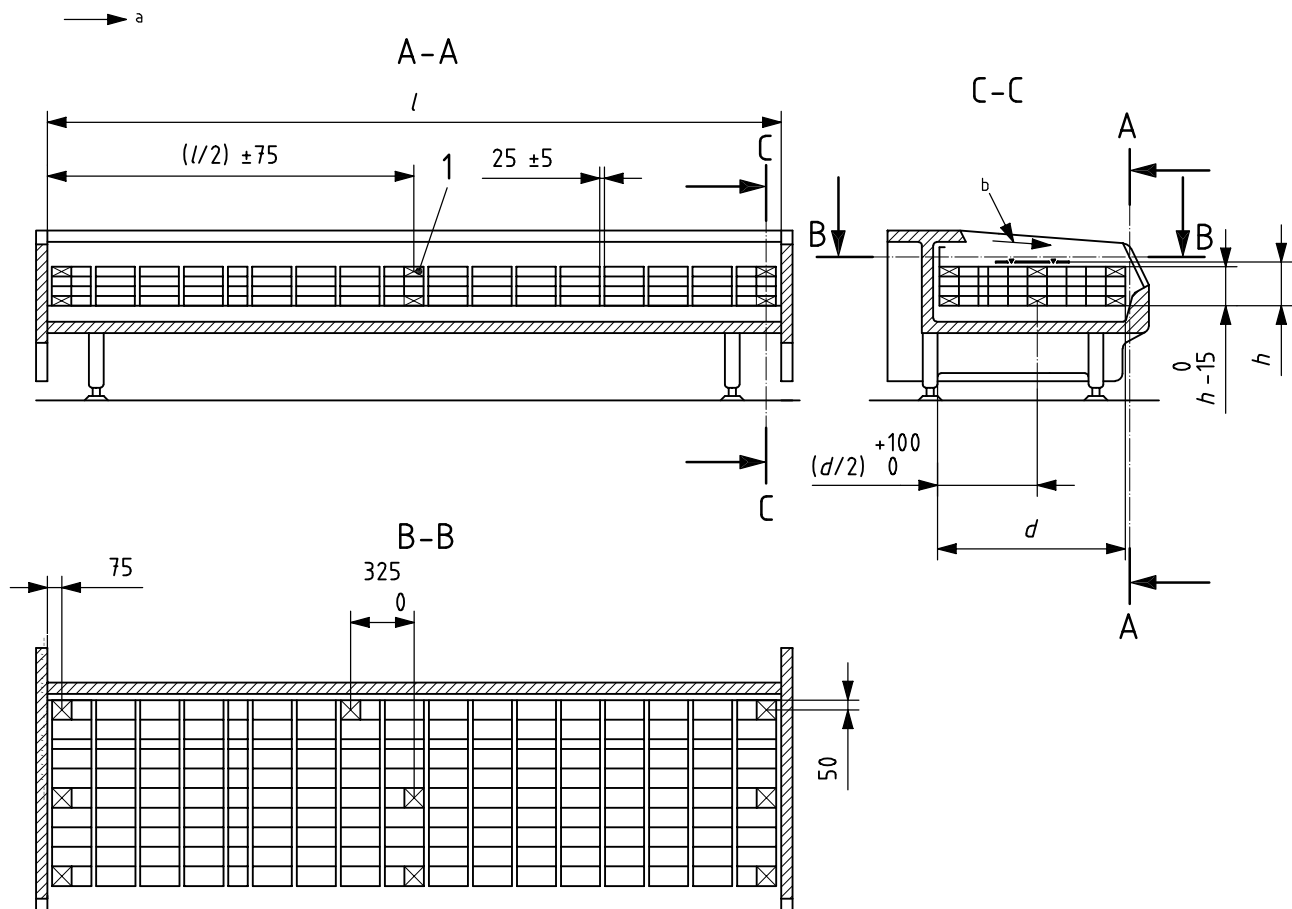
For cabinets with a minimum of four superimposed refrigerated shelves, of which two are strictly identical and have

- a) the same shape and sizes (length, depth and loading height),
- b) the same air flow design (discharge and return), and
- c) the same radiation heat transfer conditions, more particularly same location and intensity of the lower and upper lighting devices,

M-packages shall be located as follows:

- with two identical refrigerated shelves — on the lower one (see Figure 20, where the second and the third shelves from the top are identical);
- with three identical refrigerated shelves — on the central one (see Figures 21 and 24, where the second, the third and the fourth shelves from the top are identical).

Dimensions in millimetres

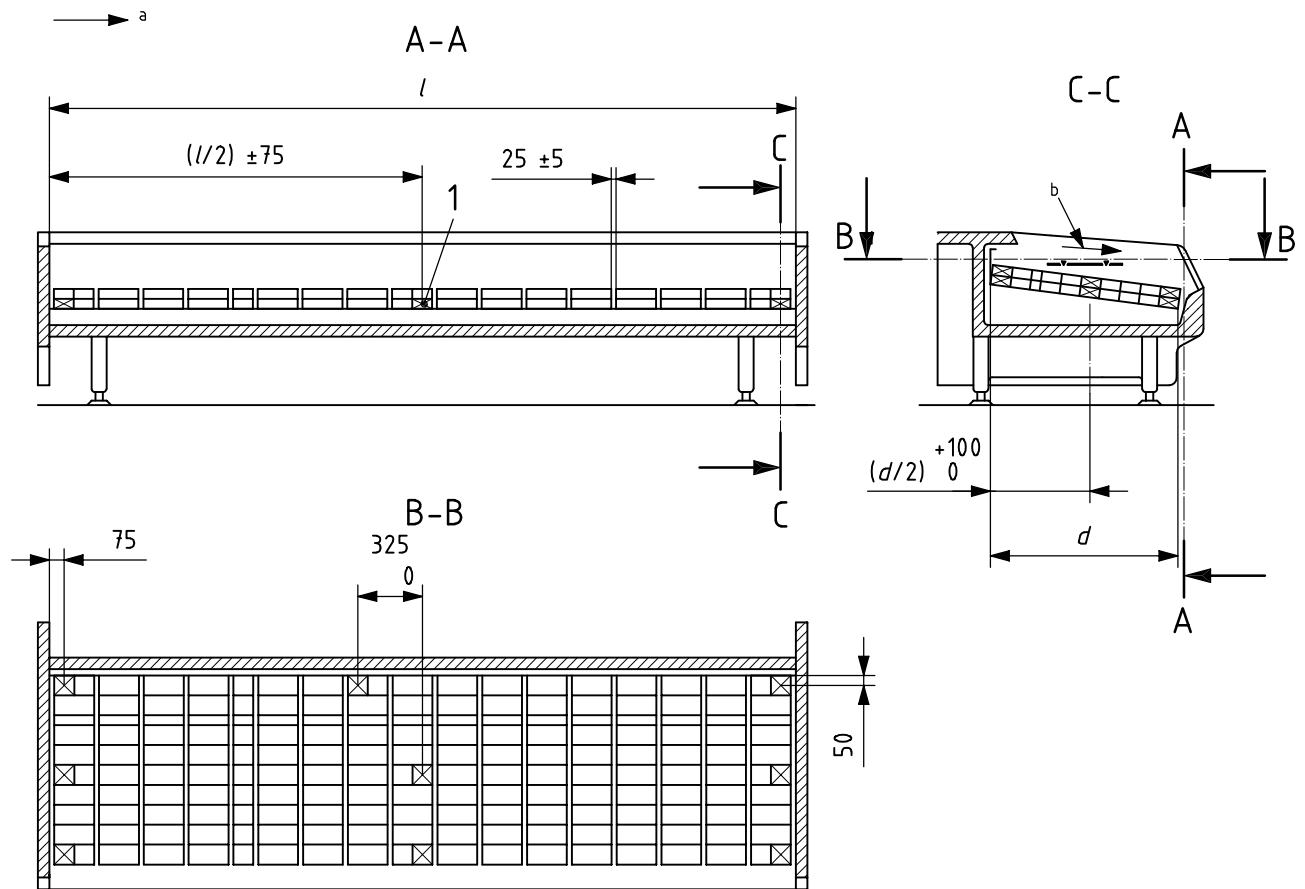


Key

- l length of cabinet
- d depth of base deck
- h height at load limit
- 1 M-package
- a Air currents parallel to the plane of the opening (in longitudinal direction).
- b Direction of forced air flow.

Figure 11 — Self service counter provided with forced air cooling (horizontal, open)

Dimensions in millimetres

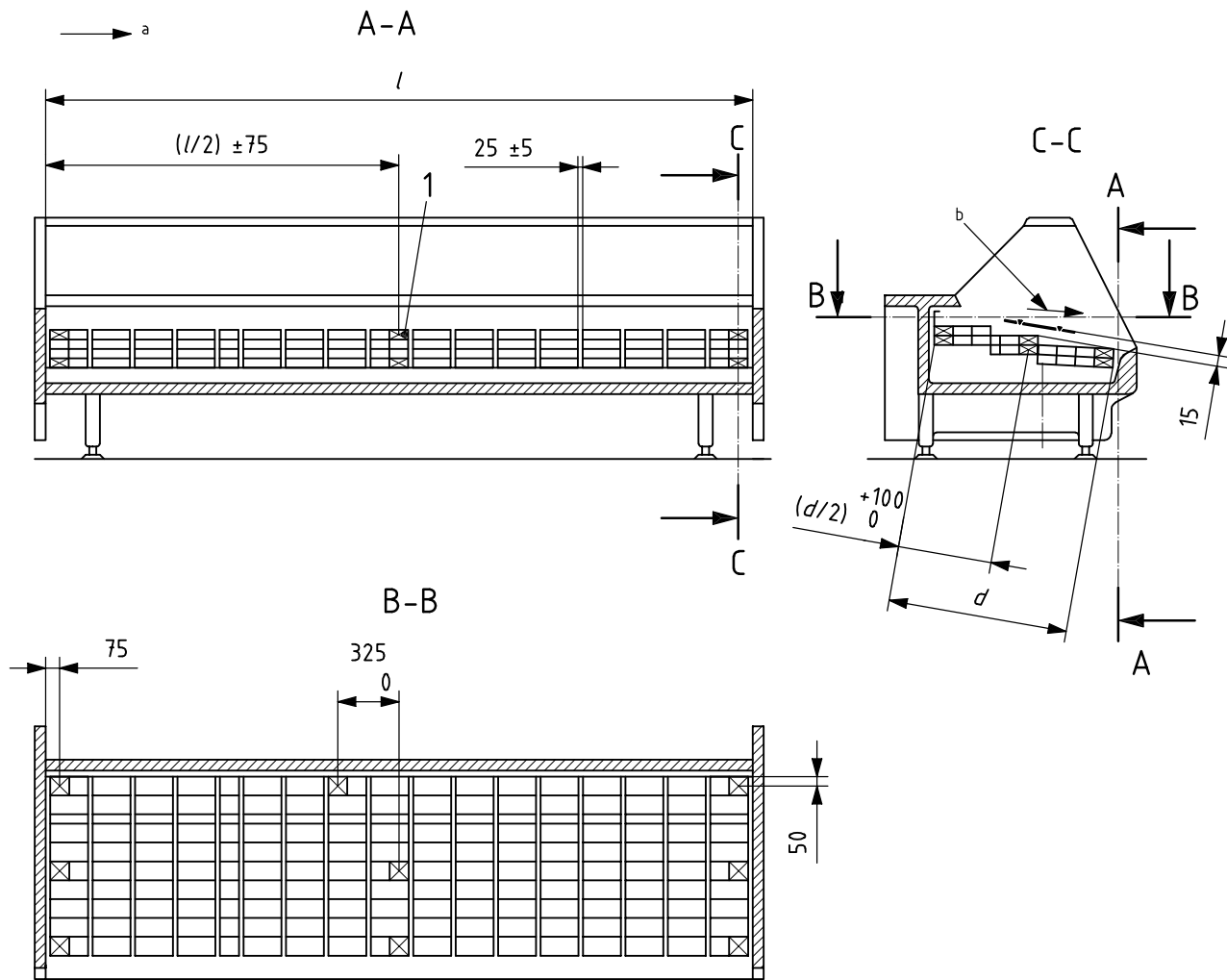


Key

- l* length of cabinet
- d* depth of base deck
- h* height at load limit
- 1 M-package
- a Air currents parallel to the plane of the opening (in longitudinal direction).
- b Direction of forced air flow.

Figure 12 — Chilled, self-service counter provided with forced air cooling for sensitive foodstuffs (horizontal, open)

Dimensions in millimetres

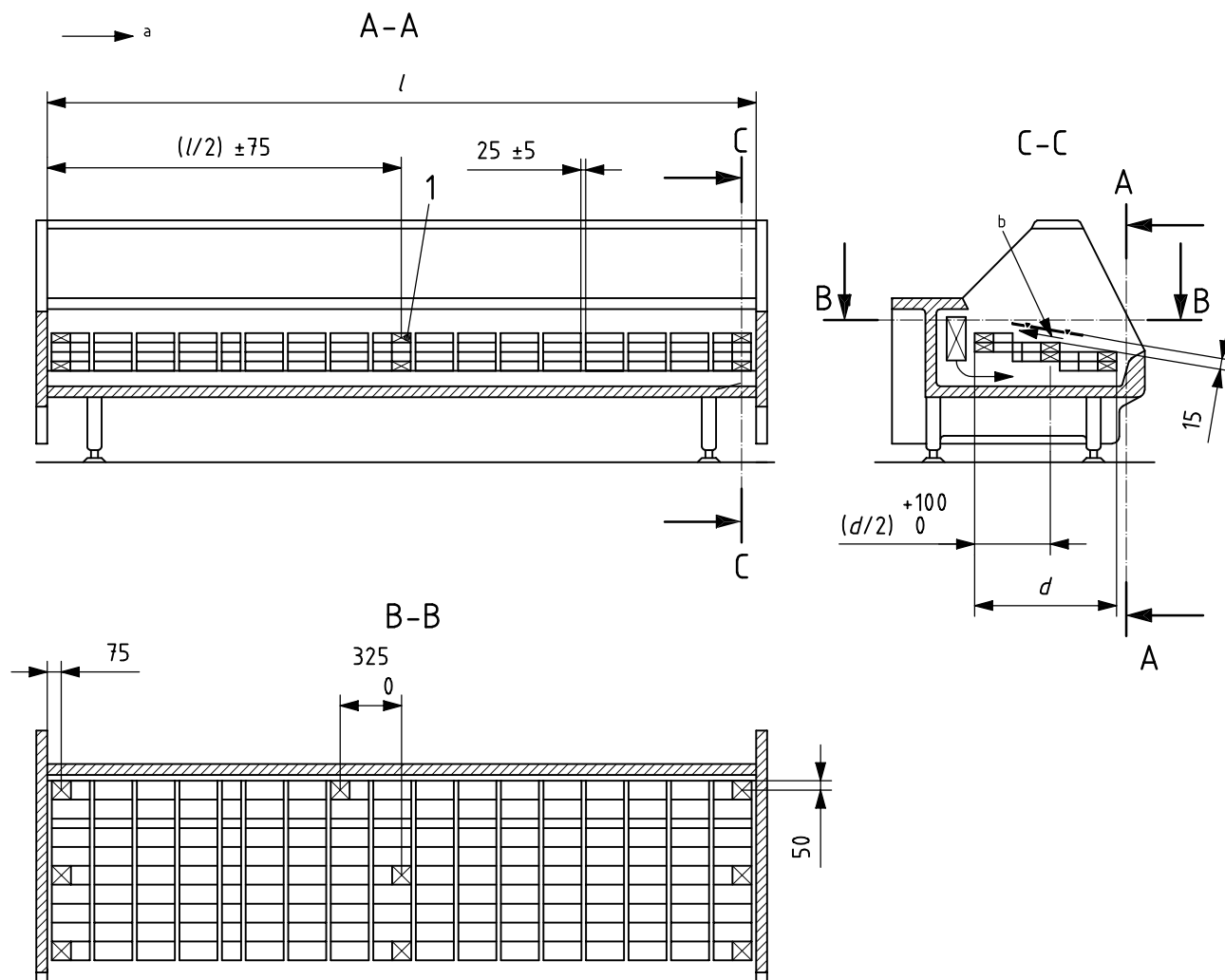


Key

- l length of cabinet
- d depth of base deck
- h height at load limit
- 1 M-package
- a Air currents parallel to the plane of the opening (in longitudinal direction).
- b Direction of forced air flow.

Figure 13 — Serve-over counter provided with forced air cooling (horizontal)

Dimensions in millimetres

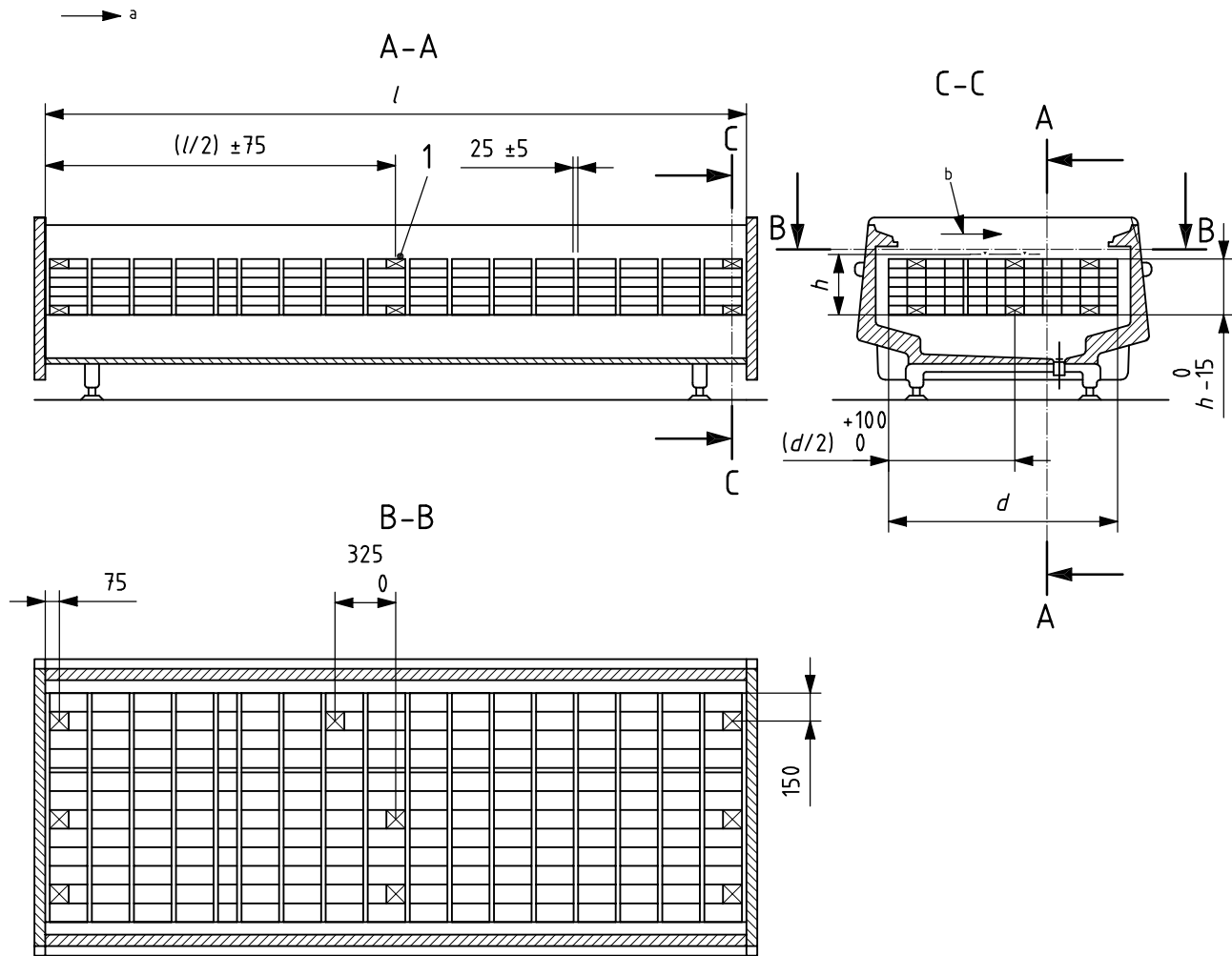


Key

- l length of cabinet
- d depth of base deck
- h height at load limit
- 1 M-package
- a Air currents parallel to the plane of the opening (in longitudinal direction).
- b Direction of forced air flow.

Figure 14 — Serve-over counter provided with natural convection cooling (horizontal)

Dimensions in millimetres

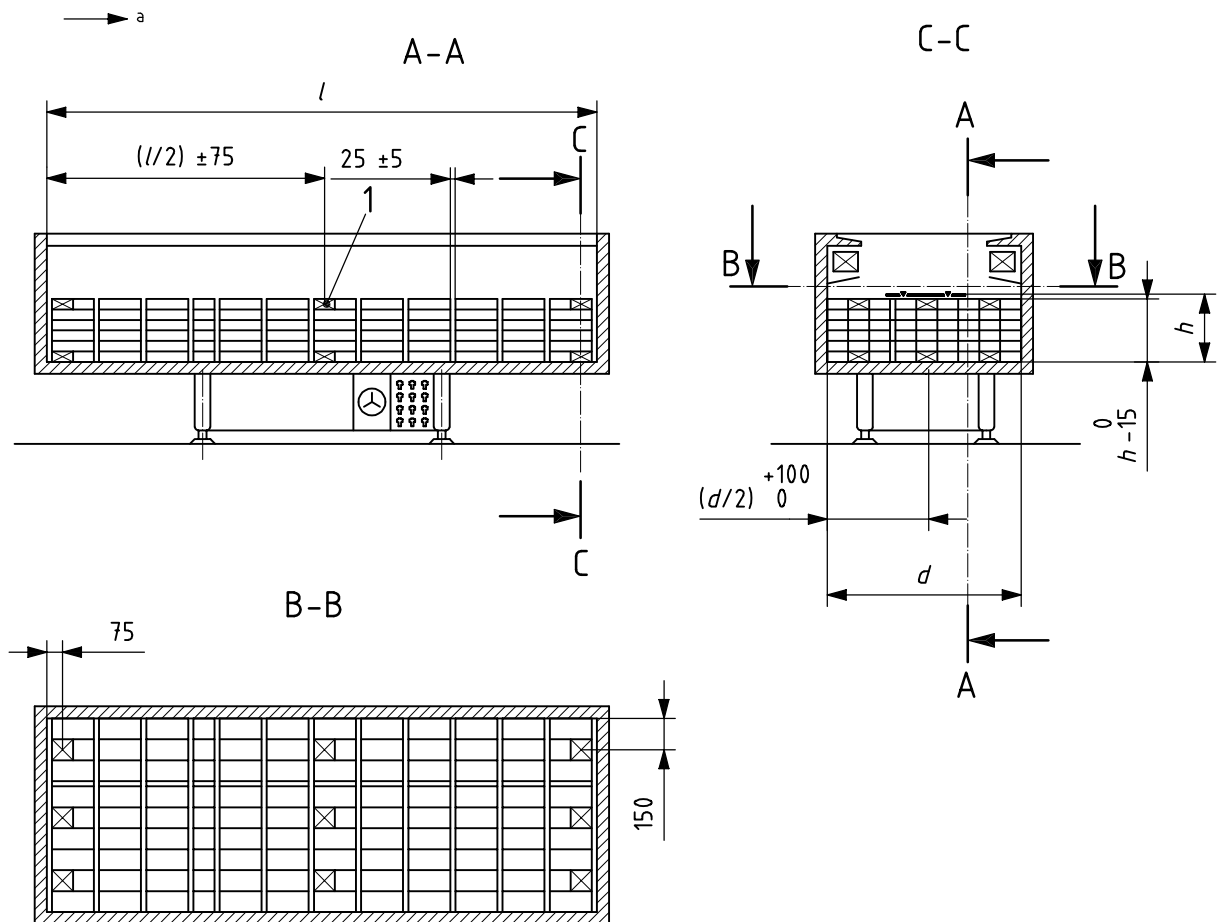


Key

- l* length of cabinet
- d* depth of base deck
- h* height at load limit
- 1 M-package
- a* Air currents parallel to the plane of the opening (in longitudinal direction).
- b* Direction of forced air flow.

Figure 15 — Open island cabinet provided with forced air cooling (horizontal, open)

Dimensions in millimetres

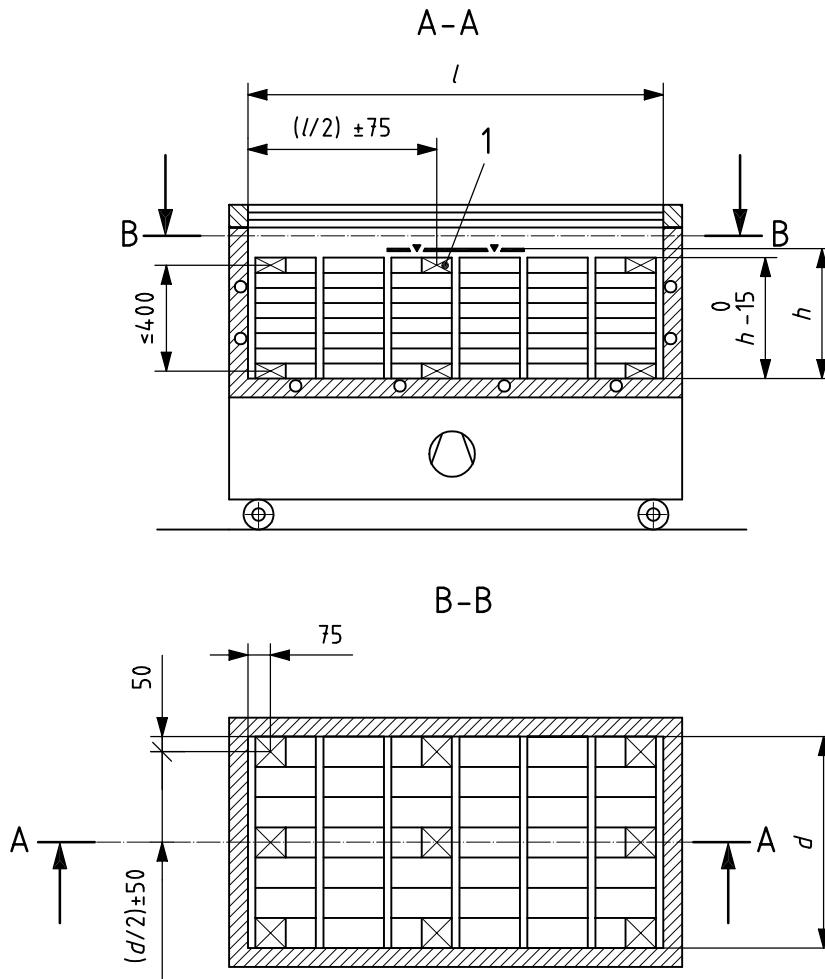


Key

- l length of cabinet
- d depth of base deck
- h height at load limit
- 1 M-package
- a Air currents parallel to the plane of the opening (in longitudinal direction).

Figure 16 — Open island cabinet provided with natural convection cooling (horizontal, open)

Dimensions in millimetres

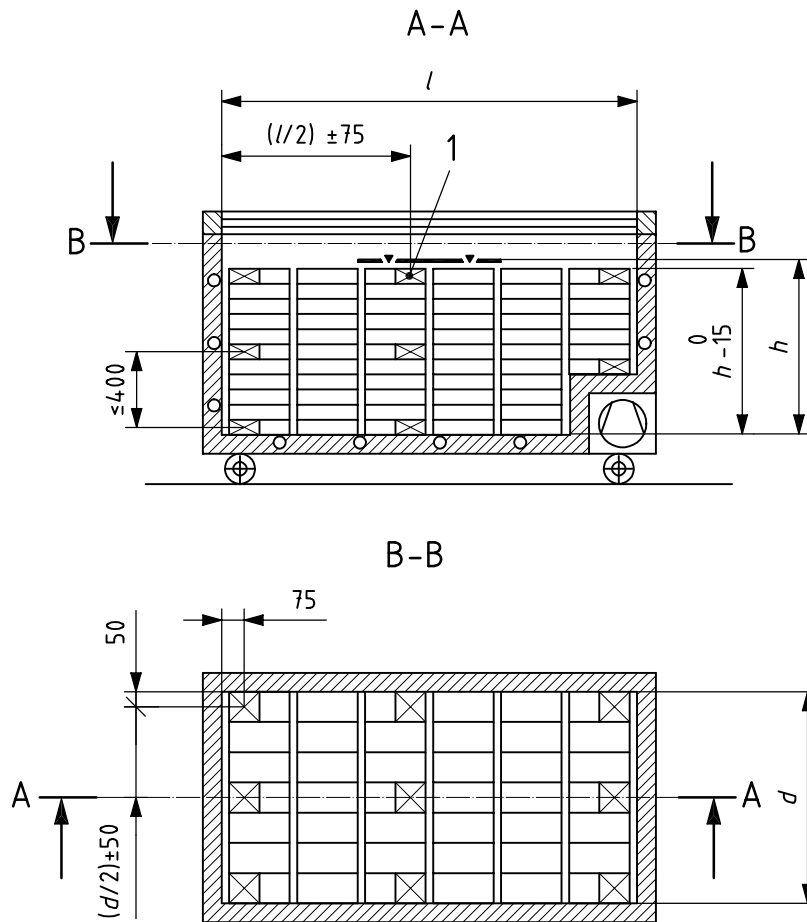


Key

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

Figure 17 — Glass-lid island cabinet with flat base deck with and without tubes laid at base (horizontal, closed)

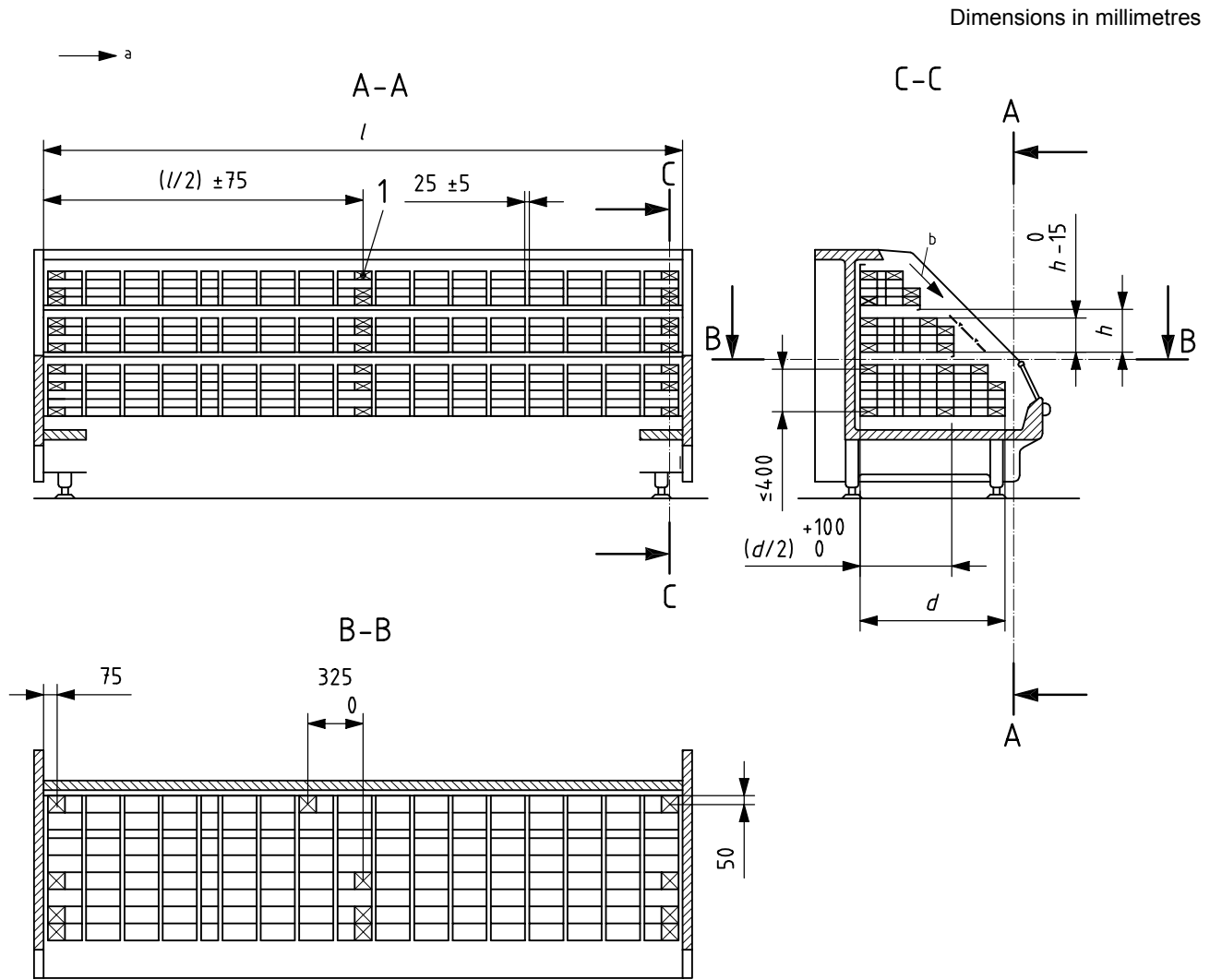
Dimensions in millimetres



Key

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

Figure 18 — Glass-lid island cabinet with stepped base deck with and without tubes laid at base (horizontal, closed)

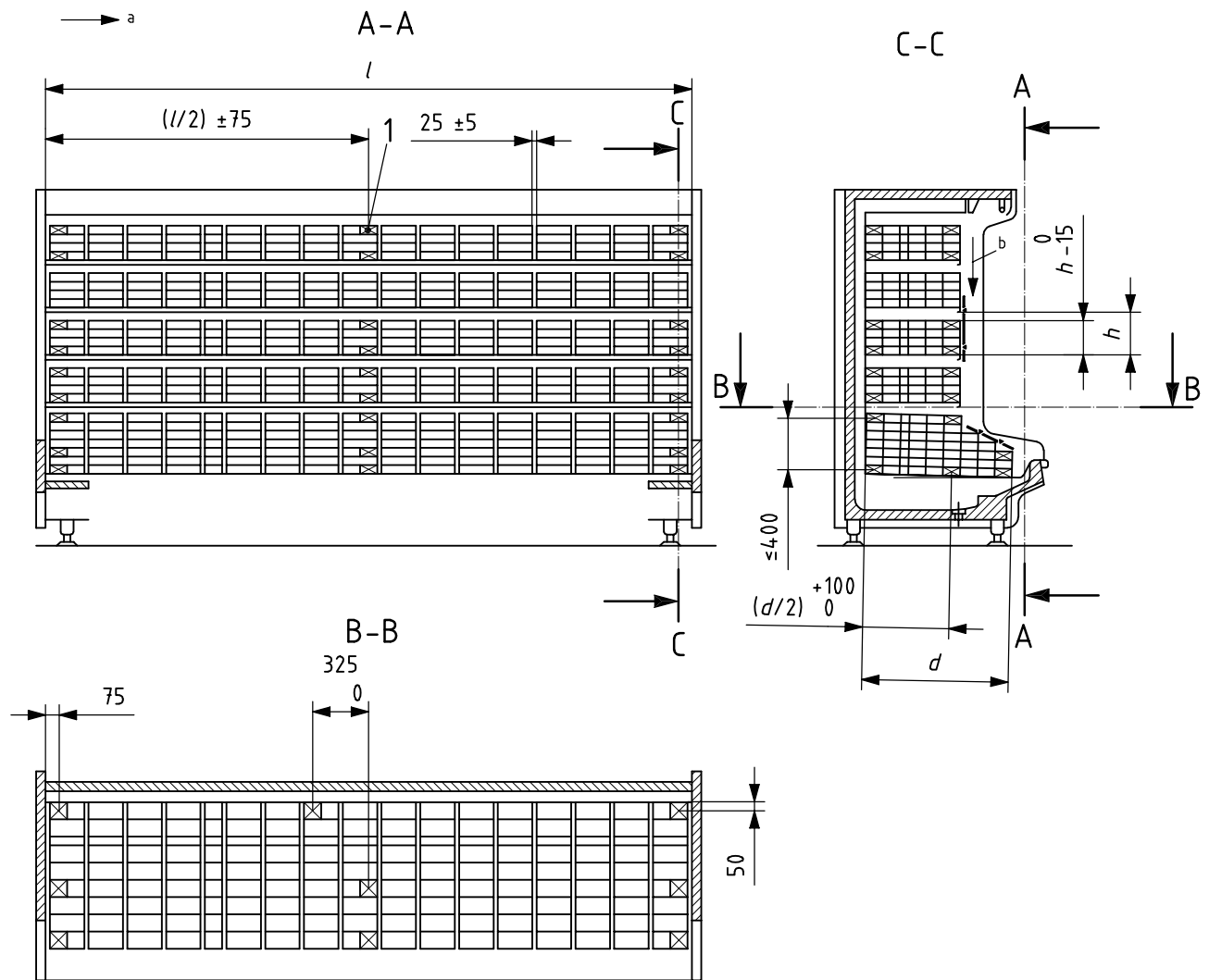


Key

- l length of cabinet
- d depth of base deck
- h height at load limit
- 1 M-package
- a Air currents parallel to the plane of the opening (in longitudinal direction).
- b Direction of forced air flow.

Figure 19 — Semi-vertical cabinet provided with forced-air cooling (vertical, open)

Dimensions in millimetres

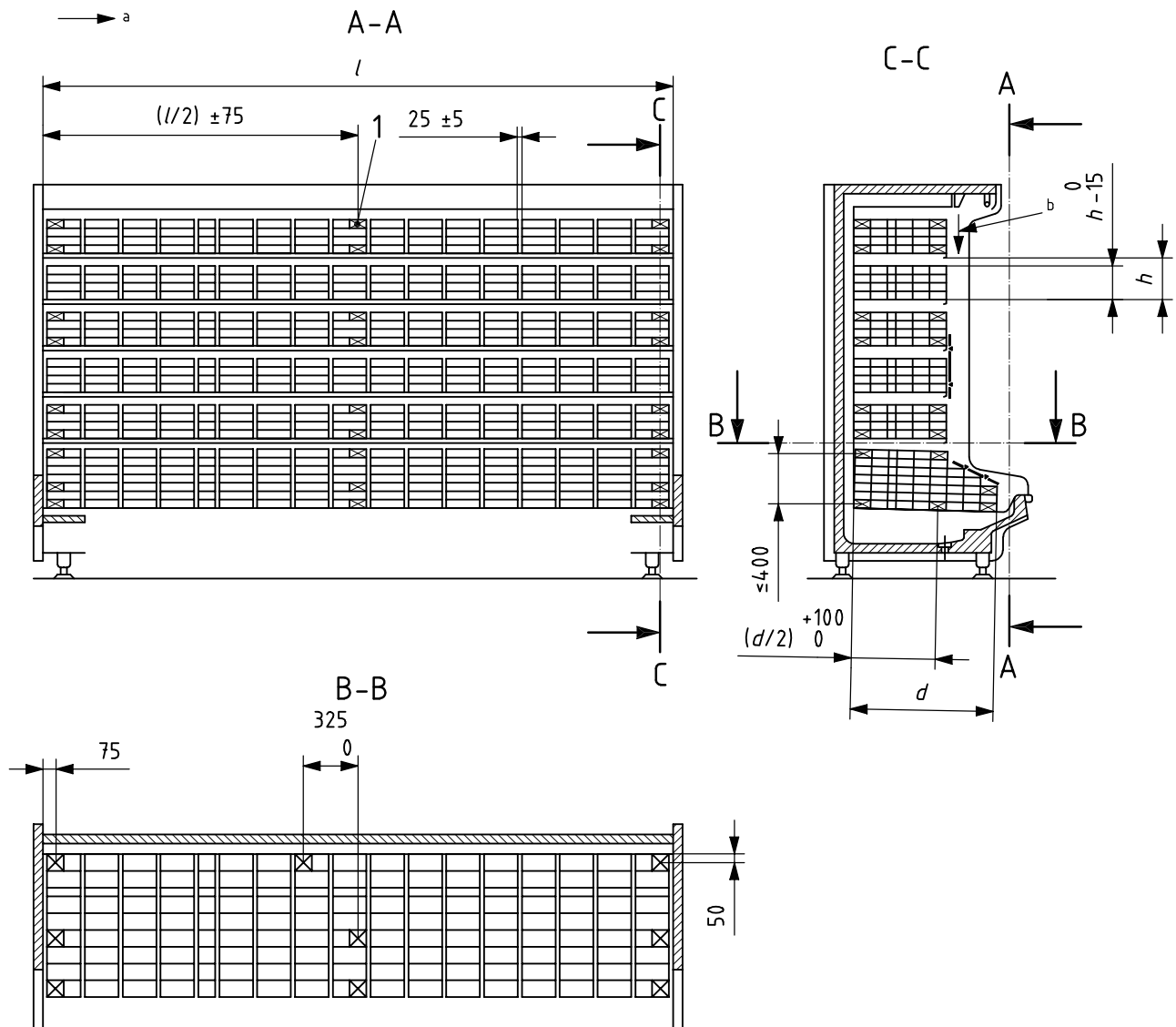


Key

- l* length of cabinet
- d* depth of base deck
- h* height at load limit
- 1 M-package
- a* Air currents parallel to the plane of the opening (in longitudinal direction).
- b* Direction of forced air flow.

Figure 20 — Multi-deck cabinet provided with forced-air cooling (vertical, open)

Dimensions in millimetres

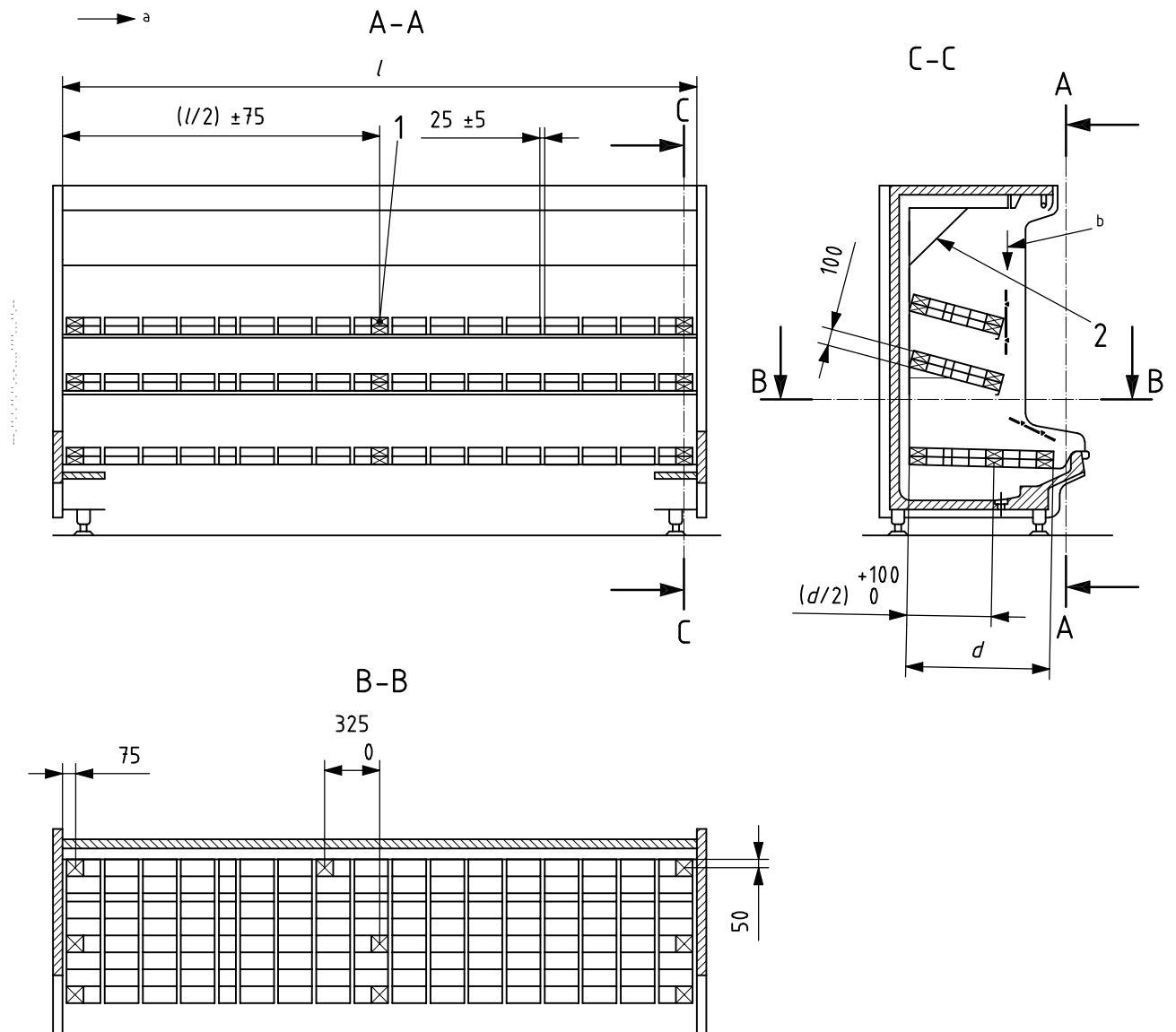


Key

- l* length of cabinet
- d* depth of base deck
- h* height at load limit
- 1 M-package
- a* Air currents parallel to the plane of the opening (in longitudinal direction).
- b* Direction of forced air flow.

Figure 21 — Multi-deck cabinet provided with forced-air cooling (vertical, open)

Dimensions in millimetres

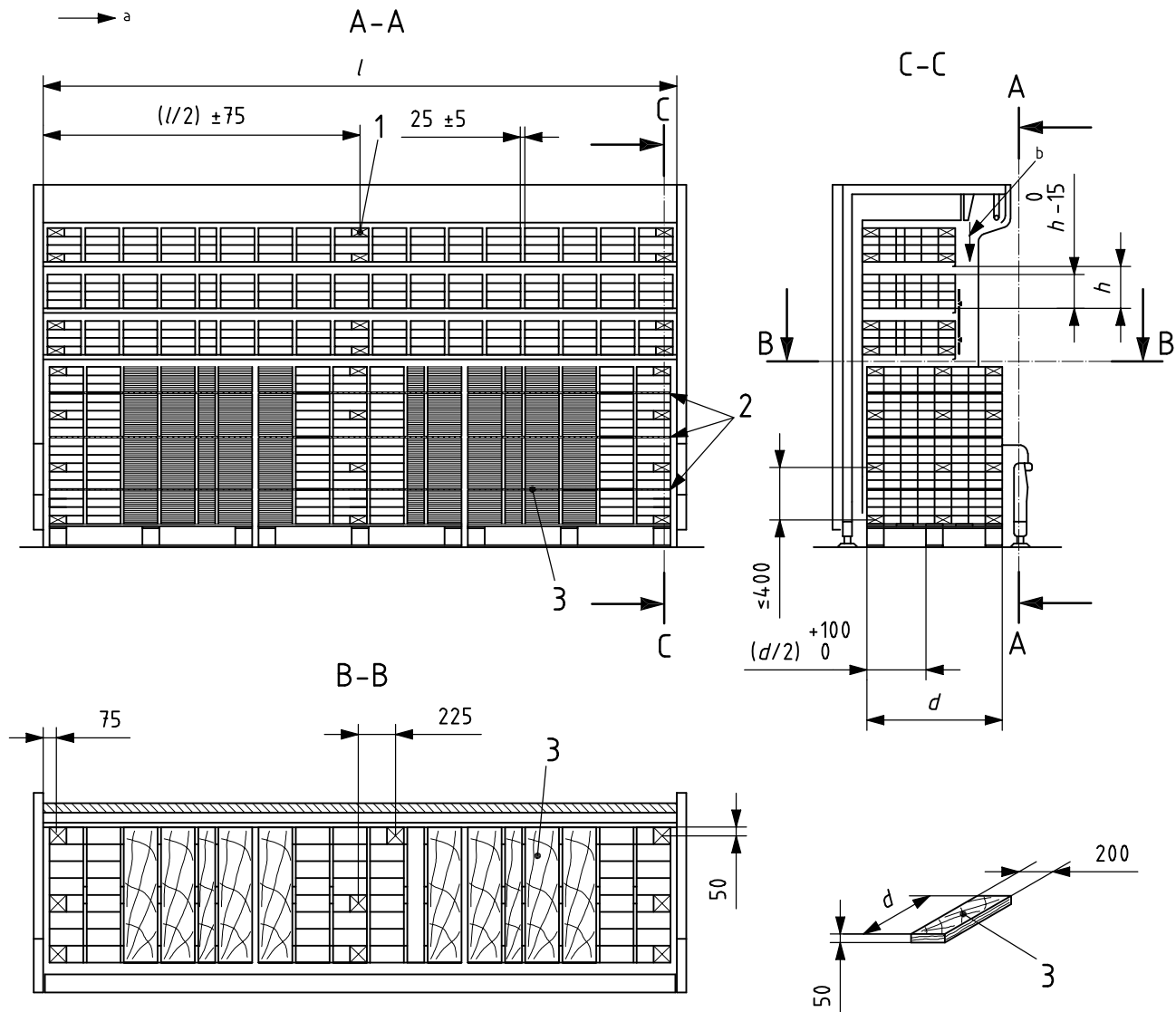


Key

- l length of cabinet
- d depth of base deck
- h height at load limit
- 1 M-package
- 2 mirror
- a Air currents parallel to the plane of the opening (in longitudinal direction).
- b Direction of forced air flow.

Figure 22 — Chilled, multi-deck cabinet provided with forced-air cooling for sensitive foodstuffs (vertical, open)

Dimensions in millimetres

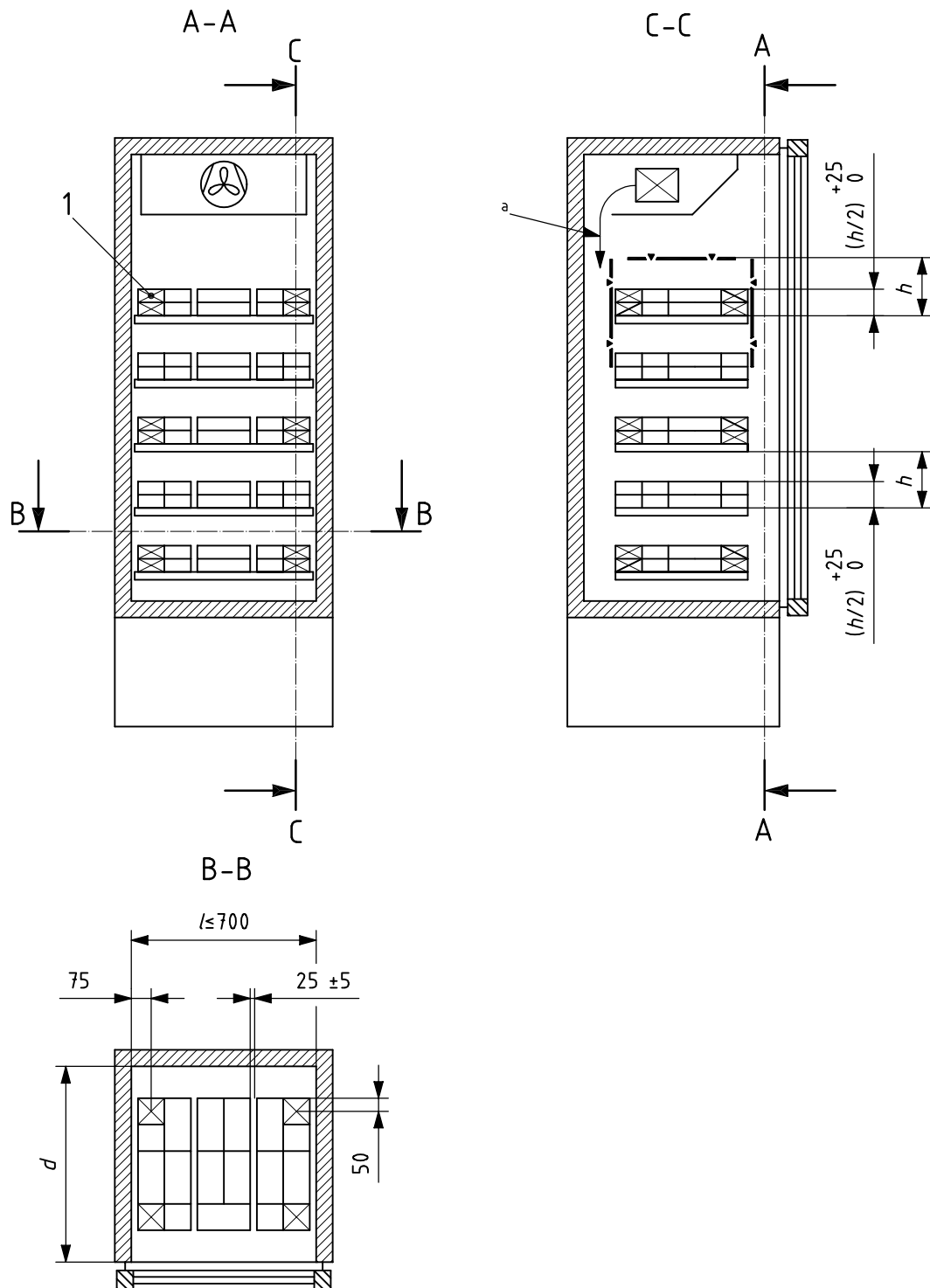


Key

- l* length of cabinet
- d* depth of base deck
- h* height at load limit
- 1 M-package
- 2 grids
- 3 wood loading
- a Air currents parallel to the plane of the opening (in longitudinal direction).
- b Direction of forced air flow.

Figure 23 — Chilled, roll-in cabinet provided with forced air cooling (vertical, open)

Dimensions in millimetres



Key

- l* length of cabinet
- d* depth of base deck
- h* height at load limit
- 1 M-package
- a Direction of forced air flow.

Figure 24 — Glass door cabinet (vertical, closed)

5.3.2.4 Running in

When a cabinet with a remote condensing unit is tested, the operating conditions shall comply with those stated by the cabinet manufacturer.

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

The manufacturer's recommended routine of defrosting shall be followed. Before tests are started, the cabinet shall be switched on and allowed to run for at least 2 h at the specified climate class with no packages in the cabinet 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 cabinet shall be filled with test packages and M-packages according to 5.3.2.3 for the tests.

After loading, the cabinet shall be operated until stable conditions have been reached (see 5.3.2.5) and during the test period (see 5.3.2.6). The test room shall be maintained at the desired climate class as specified in 5.3.1, while the temperatures of the M-packages are recorded.

For cabinets intended to be switched off at night, it is recognized that stable conditions might not be reached. After the 2 h running-in period without packages these cabinets shall operate for at least 2 h after loading before the test period starts.

5.3.2.5 Stable conditions

The temperatures will vary cyclically and the length of the cycle is dependent on the time between two successive defrost periods.

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.

5.3.2.6 Test period

The test period shall have the following duration:

- a) not less than 12 h for cabinets intended to be switched off at night;
- b) not less than 24 h for closed and all other cabinets, under stable conditions.

5.3.2.7 Lighting and night-covers

If the test cabinet is fitted with lighting, carry out the tests according to 5.3.3, 5.3.4, 5.3.5 and 5.3.6 as follows:

- a) first, leave the cabinet lighting switched on continuously for a period of 24 h;
- b) second, leave the cabinet lighting switched on for a period of 12 h; followed by 12 h with the cabinet lighting switched off.

If night-covers are supplied for open cabinets, carry out the tests as follows:

- a) first, with the night-covers removed, leave the cabinet lighting on continuously for a period of 24 h;
- b) second, with the night-covers removed, leave the cabinet lighting switched on for a period of 12 h; followed by 12 h with the night-covers on and the cabinet lighting switched off.

5.3.2.8 Accessories

An additional, separate test shall be conducted if performance-enhancing accessories are fitted, and this shall be stated in the test report (see Clause 6).

5.3.2.9 Liquid refrigerant inlet condition

The liquid refrigerant temperature at the cabinet inlet shall not be more than 10 °C above the specified test room temperature. During the test no “flash gas” condition shall occur. This shall be confirmed by observation.

5.3.2.10 Power supply

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

5.3.2.11 Testing several cabinets in the same room

If more than one cabinet 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 cabinet are in accordance with the test requirements specified in 5.3.1. to 5.3.2.

5.3.3 Temperature test

5.3.3.1 Test conditions

The cabinet shall be located and loaded in accordance with 5.3.1 and 5.3.2, operated in accordance with the manufacturer's instructions at the conditions appropriate to the test room climate class for which it is intended (see 5.3.1.3.1), and then operated for the test period defined in 5.3.2.6, during which measurements shall be recorded. Lighting, and night-covers, if any, shall be manipulated according to 5.3.2.7.

5.3.3.2 Closed refrigerated cabinets

The test for closed refrigerated cabinets shall always be carried out on a complete cabinet, regardless of the number of doors or lids. Each door or lid shall be opened six times per hour. Where more than one door or lid pertains to the cabinet to be tested, the sequence in which the doors and lids are opened shall be staggered — where there are two doors, for example, open door no. 1 at 0 min, door no. 2 at 5 min, door no. 1 at 10 min, door no. 2 at 15 min, and so on.

The doors shall be opened beyond an angle of 60°.

The door or lid shall be open for a total of 6 s. During this period the door shall be kept open beyond the angle of 60° for 4 s.

At the start of the opening cycle, each door or lid shall be opened for 3 min. Where a cabinet is provided with more than one door or lid, each door or lid shall be opened for 3 min consecutively.

Within the test period, the doors or lids shall be opened cyclically for 12 h within 24 h.

For closed cabinets, only test b) of 5.3.2.7 is required.

5.3.3.3 Defrost check

After the temperature test period at the end of the next defrost period — for closed cabinets, a minimum 12 h after the end of the openings — the cabinet shall be switched off and, as necessary, unloaded as quickly as possible. All surfaces, excluding test packages, within the refrigerated space shall be examined for any residual water, ice, frost or snow after dismantling as necessary, accessories and parts.

If water, ice, frost or snow is evident and/or if the temperature test performance level is not being maintained, continue to test for a second test period under the same conditions and with no adjustment to the control device(s).

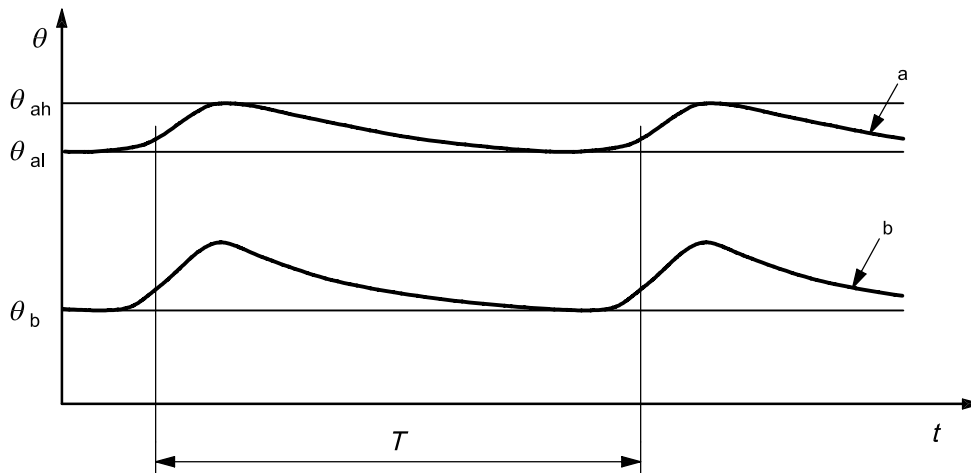
5.3.3.4 Temperature curves of M-packages

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 25);
- b) the temperature of the coldest M-package (i.e. the one with the lowest minimum temperature) (see Figure 25);
- c) the arithmetic mean temperature of all M-packages (see Figure 26).

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

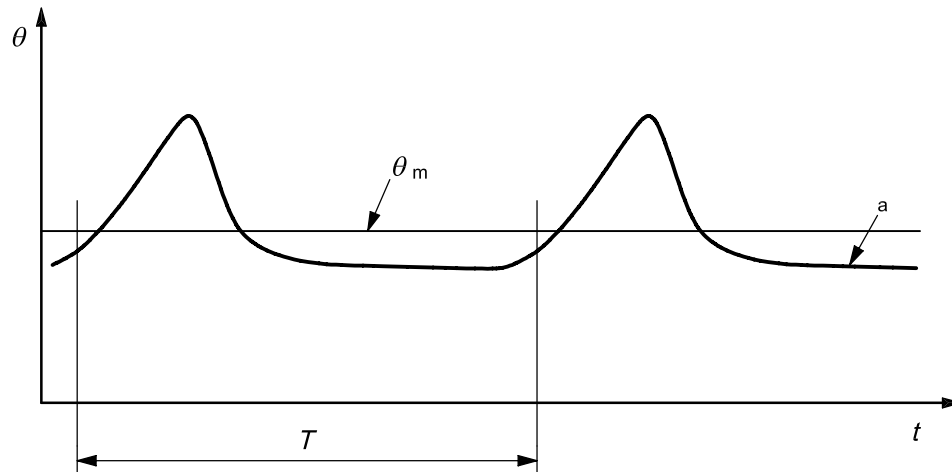
In the case of cabinets with multiple temperature classes, curves a, b and c shall be prepared separately for each temperature class.



Key

- θ temperature
- θ_{ah} highest temperature of warmest M-package
- θ_b lowest temperature of coldest M-package
- θ_{al} lowest temperature of warmest M-package
- t time
- T test period
- a Temperature curve a of warmest M-package.
- b Temperature curve b of coldest M-package.

Figure 25 — Warmest and coldest M-package temperatures (curves a and b)

**Key**

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

Figure 26 — Arithmetic mean temperature of M-packages (curve c)

5.3.3.5 Calculation of average mean temperature

The average instant temperature at measuring sample n of all M-packages, θ_{cn} (curve c in Figure 26), is expressed by the following equation:

$$\theta_{cn} = \frac{1}{K_{\max c}} \times \sum_{k=1}^{K_{\max c}} (\theta_k)_n$$

where

- n is the time index for the instant measuring sample;
 k is the index for the individual M-package;
 $K_{\max c}$ 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:

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

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.

5.3.4 Water vapour condensation test

5.3.4.1 Test conditions

The cabinet shall be located and loaded in accordance with 5.3.1 and 5.3.2, 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 to 5.3.2.6, during which measurements shall be recorded. Lighting and night-covers, if any, shall be manipulated according to 5.3.2.7. The test may be carried out during the temperature test.

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 cabinet 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 cabinet shall be carefully wiped dry with a clean cloth. If the cabinet is fitted with automatic defrosting equipment this test period shall be selected during the period when condensation is most likely to occur.

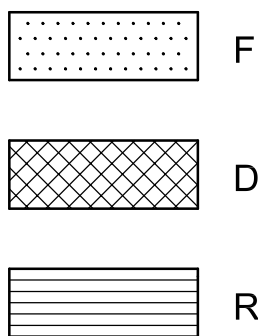
5.3.4.2 Test results

The cabinet 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:

- a) all cabinet surfaces, whether adjacent or otherwise, remain free of moisture by the provision of insulation, ventilation or heating to maintain a temperature above dew point for the climate class specified (Table 3);
- b) internal surfaces, wherever practical, remain free of moisture collection or ice gather;
- c) mirrors that can periodically mist during defrost clear by evaporation on the return to refrigeration cycle.

5.3.4.3 Expression of results

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 27 shall be used.



- Key**
- F fog/mist
 - D droplets
 - R running water

Figure 27 — Condensation code

5.3.5 Electrical energy consumption test

5.3.5.1 Test conditions

The cabinet shall be located and loaded in accordance with 5.3.1 and 5.3.2, 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 to 5.3.2.6, during which measurements shall be recorded. Lighting and night-covers, if any, shall be manipulated according to 5.3.2.7.

The test shall be carried out during the temperature test.

5.3.5.2 Cabinets fitted with incorporated condensing unit

For cabinets with an incorporated condensing unit the direct electrical energy consumption (DEC) equals the total energy consumption (TEC), as it includes the compressor energy consumption. Refrigeration electrical energy consumption (REC) is not defined for these cabinets.

Measure the TEC, including the compressor energy consumption, reported in kilowatt hours per 24-hour period, the compressor switching on/off frequency and the relative running time (ratio of running time to overall duration of a measurement cycle excluding defrost time), with all fitted electrical power-using components switched on.

5.3.5.3 Cabinets with remote condensing unit

For cabinets with a remote condensing unit the DEC does not include the REC.

Measure the DEC of the cabinet only, with all fitted electrical power-using components switched on.

The DEC recorded for each test shall be the summation of all electrical energy consumed by the refrigerated cabinet without the control unit during the test period.

NOTE If, for technical reasons, it is too difficult to measure separately the component powers, it is possible to use the DEC directly measured.

5.3.6 Heat extraction rate measurement when condensing unit is remote from cabinet

5.3.6.1 Test conditions

5.3.6.1.1 General

The cabinet shall be located and loaded in accordance with 5.3.1 and 5.3.2, 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 to 5.3.2.6, during which measurements shall be recorded. Lighting and night-covers, if any, shall be manipulated according to 5.3.2.7.

The test shall be carried out during the temperature test.

The refrigeration system shall be connected to the cabinet as given below.

The refrigerant inlet and outlet temperatures shall be measured using temperature sensors directly inserted into the pipe or inserted into pockets or clamped between the piping and a copper recovery half-sleeve on the inlet and outlet pipe-lines positioned no further than 150 mm from the cabinet exterior [see Figures 28 a) and 29 a)].

Where thermocouples or similar devices are utilised, the sensor cables shall be arranged such that external influences on the connection cables are eliminated by the use of insulation.

Temperature sensors, connecting wires and pipelines shall be insulated from the outlet of the cabinet up to at least 150 mm beyond the measuring points.

A flow measuring device (flow meter) shall be installed in the liquid inlet supply line to the cabinet in order to measure mass flow rate of the liquid refrigerant.

A liquid sight glass shall be installed in the liquid piping downstream and, if necessary, optionally upstream of the flow meter in order to verify the vapour-free state of the refrigerant being supplied to the cabinet during the test period.

A temperature sensor shall be installed as stated above within, or at (150 ± 10) mm upstream of, the liquid flow meter, with the piping being insulated at least 150 mm upstream and from the sensor to the inlet of the flow meter.

A measurement of pressure shall be carried out at the cabinet outlet for compression type systems and both inlet and outlet for indirect type systems at less than 150 mm from the cabinet.

The heat extraction rate necessary for the cabinet shall be determined from temperature, pressure and flow rate readings which allow a resultant accuracy of $\pm 5\%$.

5.3.6.1.2 Specific test conditions for cabinets intended for connection to compression-type refrigerating systems

The refrigeration system remotely located from the cabinet shall be connected to the cabinet in accordance with Figure 28 a).

The refrigeration system selected for the test shall be capable of operating as follows:

- with the refrigerant at the saturated evaporating pressure or temperature in service at the cabinet outlet specified by the manufacturer;
- with the liquid refrigerant vapour free supplied at the cabinet inlet at a temperature not more than $10\text{ }^{\circ}\text{C}$ above the specified test room temperature, or supplying sub-cooled liquid when specified.

In both conditions, the liquid temperature shall be stated.

An oil separator may be installed at the discharge of compressor to minimize the oil content of the refrigerant.

5.3.6.1.3 Specific test conditions for cabinets intended for connection to indirect-type refrigerating systems

The indirect-type refrigerating system shall be connected to the cabinet intended for this system in accordance with Figure 29 a).

The refrigerating system shall be capable of supplying secondary refrigerant fluid at the temperature and flow rate specified by the manufacturer.

During defrost and cycling, the secondary refrigerant circulates through the bypass valves.

5.3.6.2 Determination of heat extraction rate

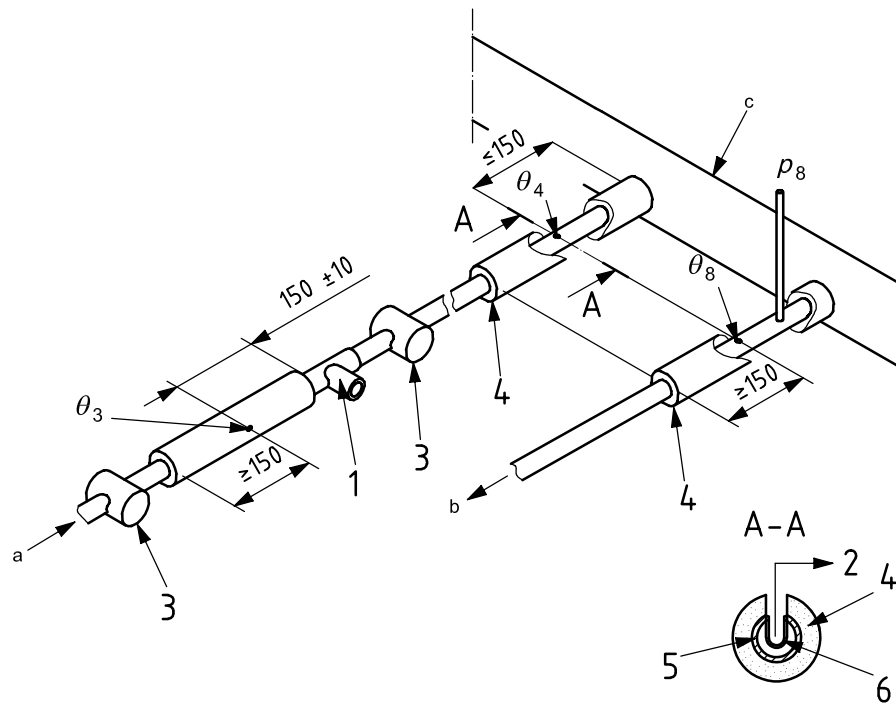
5.3.6.2.1 Cabinets intended for connection to compression-type refrigerating systems (see Figure 28)

The instant heat extraction rate in kilowatts is defined as

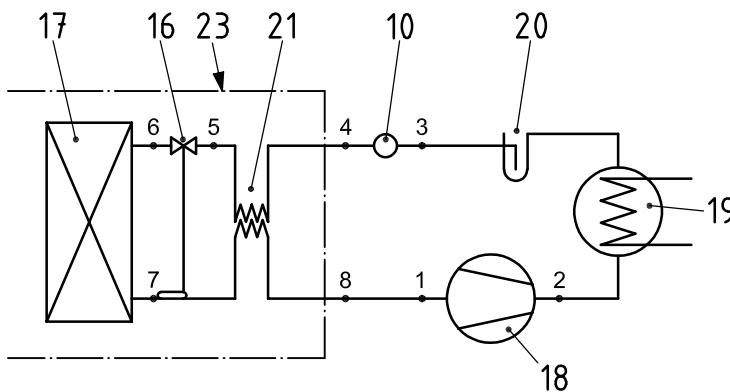
$$\Phi_n = q_m (h_8 - h_4)$$

for each individual measuring instant, where n indicates the measuring sample ($\Phi_n = 0$ kW during stopping and defrost time).

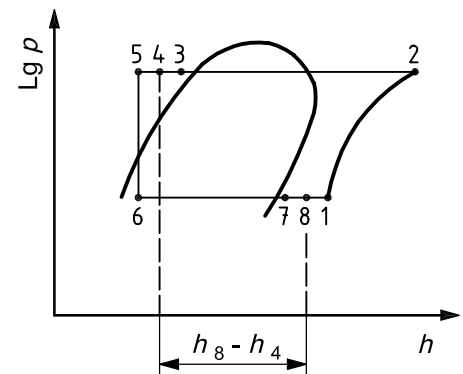
Dimensions in millimetres



a) Connection to remote compression-type refrigerating system



b) Reference point locations



c) Pressure enthalpy diagram showing measuring points

Key

- | | |
|--|---|
| <ul style="list-style-type: none"> 1 flow meter 2 to temperature recorder 3 sight glass 4 insulation (to at least 150 mm from temperature sensor) 5 refrigerant circulation pipe 6 copper thermo-pocket for housing the temperature sensor (shall be filled with glycerine or a similar fluid) | <ul style="list-style-type: none"> 7 expansion device 8 evaporator 9 compressor 10 condenser 11 liquid receiver 12 liquid vapour heat exchanger, if any 13 cabinet |
|--|---|
- a Liquid supply.
 b Vapour return.
 c Pipe connection to cabinet.

Figure 28 — Cabinets intended for connection to compression-type refrigerating systems

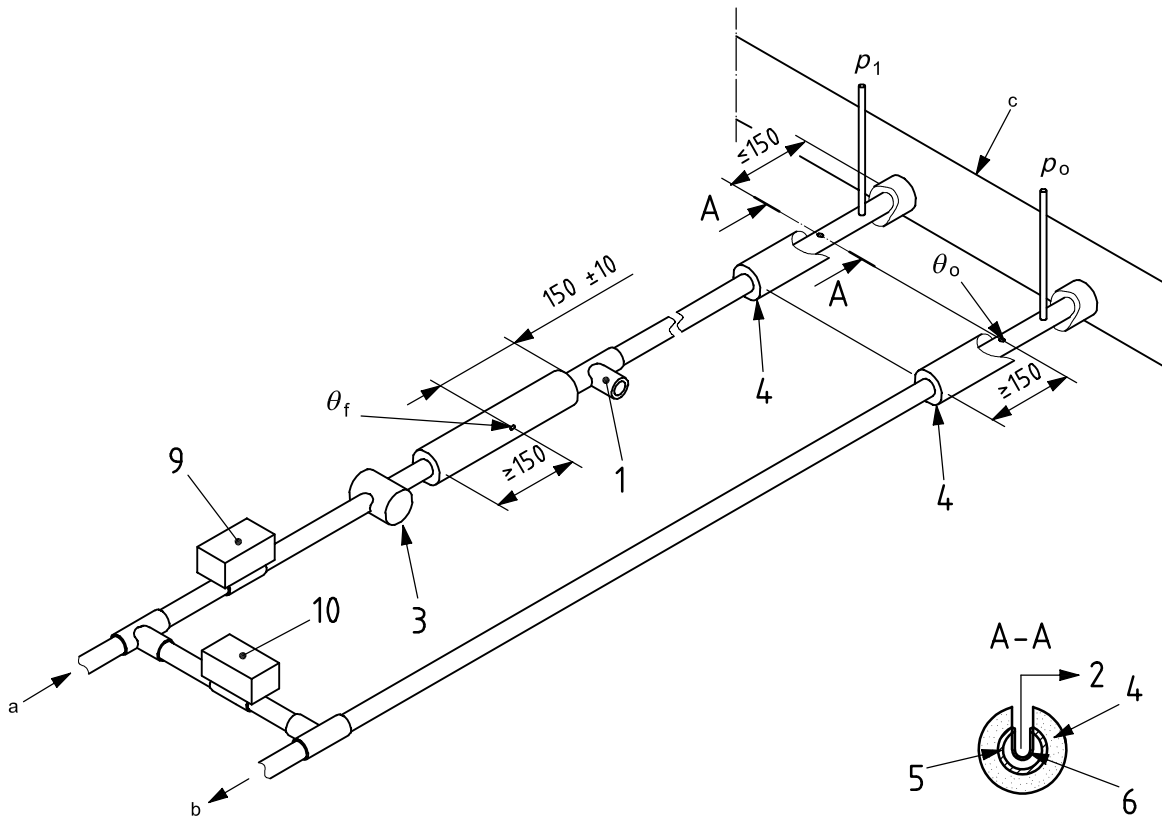
5.3.6.2.2 Cabinets intended for connection to indirect-type refrigerating systems (see Figure 29)

The instant heat extraction rate in kilowatts is defined as

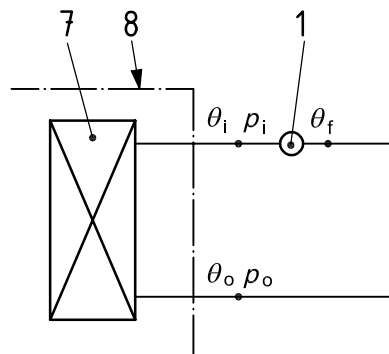
$$\Phi_n = q_m [(c_o \times \theta_o) - (c_i \times \theta_i)]$$

for each individual measuring instant, where n indicates the measuring sample ($\Phi_n = 0$ kW during stopping and defrost time).

Dimensions in millimetres



a) Connection to remote indirect-type refrigerating system



b) Reference point locations

Key

- 1 flow meter
 - 2 to temperature recorder
 - 3 sight glass
 - 4 insulation (to at least 150 mm from temperature sensor)
 - 5 refrigerant circulation pipe
 - 6 copper thermo-pocket for housing the temperature sensor (shall be filled with glycerine or a similar fluid)
 - 7 heat exchanger
 - 8 cabinet
 - 9 inlet valve: open during refrigeration, closed during switch off or defrosting
 - 10 outlet valve: closed during refrigeration, open during switch off or defrosting
- a Liquid supply.
 - b Liquid return.
 - c Pipe connection to cabinet.

Figure 29 — Cabinets intended for connection to indirect-type refrigerating systems**5.3.6.3 Method****5.3.6.3.1 General**

The summation of the instant heat extraction rates Φ_n , in kilowatts, over 24 h gives the following.

- a) Total heat extraction, Q_{tot} , in kilowatt hours (see Figures 30 to 32):

$$Q_{\text{tot}} = \sum_{n=1}^{n=N_{\text{max}}} \Phi_n \times \Delta t$$

($\Phi_n = 0$ kW during stopping and defrost time).

- b) For continuous running, the steady state heat extraction, Q_{75} , in kilowatt hours during 75 % of the refrigerating time period excluding the period just after defrost (see Figure 30):

$$Q_{75} = \sum_{i=1}^{i=n_{\text{def}}}} \left(\sum_{n=1}^{n=N_{75}} \Phi_n \times \Delta t \right)_i$$

The following shall be given when reporting the heat extraction rate for compression and indirect-type refrigerating systems:

- Φ_{run} the heat extraction rate necessary for a single cabinet installation in laboratory conditions, in kilowatts;
- Φ_{run75} for continuous running only, the steady-state heat extraction rate necessary for a single cabinet installation during 75 % of the refrigerating period, excluding the time just after defrost in laboratory conditions, in kilowatts;
- Φ_{24} the heat extraction rate necessary for a multi-cabinet installation in laboratory conditions, in kilowatts;
- $\Phi_{24\text{-def}} a$ heat extraction rate for calculating the energy consumption of a cabinet in laboratory conditions, in kilowatts.

5.3.6.3.2 Determination of heat extraction rates (see Figures 30 to 33)

The heat extraction rate necessary for a single cabinet installation, Φ_{run} , can be calculated by arithmetic averaging of the instant heat extraction rates Φ_n during the running time only (t_{run}):

$$\Phi_{run} = \frac{Q_{tot}}{t_{run}} = \frac{Q_{tot}}{24 - t_{deft} - t_{stop}}$$

The steady-state heat extraction rate necessary for a single cabinet installation during 75 % of the refrigerating period Φ_{run75} can be calculated by arithmetic averaging of the instant heat extraction rates only during 75 % of the running time, excluding the time just after defrost (t_{run75}):

$$\Phi_{run75} = \frac{Q_{75}}{0,75 t_{run}} = \frac{Q_{75}}{0,75 (24 - t_{deft}) t_{rr}}$$

The heat extraction rate necessary for a multi-cabinet installation Φ_{24} can be calculated by arithmetic averaging of the instant heat extraction rates during a whole day, including running, stopping and defrost times (t_{run} , t_{stop} and t_{deft}):

$$\Phi_{24} = \frac{Q_{tot}}{t_{run} + t_{stop} + t_{deft}} = \frac{Q_{tot}}{24}$$

A heat extraction rate for calculating the energy consumption of a cabinet $\Phi_{24-deft}$ can be calculated by arithmetic averaging of the instant heat extraction rates during a whole day excepting defrost time (t_{deft}), e.g. only during running and stopping time (t_{run} and t_{stop}):

$$\Phi_{24-deft} = \frac{Q_{tot}}{t_{run} + t_{stop}} = \frac{Q_{tot}}{24 - t_{deft}}$$

5.3.6.3.3 Calculation of REC

The refrigeration electrical energy consumption for a cabinet intended for a remote compression-type refrigerating system, REC_{RC} , is calculated from the following equation:

$$REC_{RC} = (24 - t_{deft}) \times \Phi_{24-deft} \times \frac{(T_c - T_{mrun})}{(0,34 \times T_{mrun})} = Q_{tot} \times \frac{(T_c - T_{mrun})}{(0,34 \times T_{mrun})}$$

with a constant condensing temperature of $T_c = 308,15$ K (35 °C, but calculation in Kelvin).

For a cabinet intended for an indirect type refrigerating system, the evaporation temperature T_{mrun} of the compression-type refrigerating system is lower than the secondary refrigerant temperature at the cabinet inlet (θ_i), and the evaporating temperature, which is not measured, shall be calculated as follows:

$$T_{mrun} = \theta_i - 3 \text{ K}$$

Furthermore, electrical energy is consumed by the pump(s) necessary for circulating the secondary refrigerant. This consumption is not measured and is dependent on the practical design of the secondary refrigerant circuit. As a conventional rule, the pumping energy consumption (PEC) in kilowatt hours per 24-hour period is calculated using the following equation; assuming a pressure drop in the system equalling 2,5 times the pressure drop over the cabinet and a pump efficiency of 0,5:

$$PEC = v\tau \frac{2,5 q_{mrun} (p_{irun} - p_{orun})}{0,5}$$

The factor τ in the above formula represents the running time of the pump in hours per day. As a conventional rule, τ is established as follows:

- for systems with hot brine defrost, $\tau = 19 \text{ h}/24 \text{ h}$;
- for all other systems, $\tau = 18 \text{ h}/24 \text{ h}$.

Due to a lack of sufficient (measured) data, the prescribed values for τ shall be seen as preliminary choices that could need alteration.

The refrigeration electrical energy consumption for a cabinet intended for a remote indirect refrigerating system, REC_{RI} , in kilowatt hours per 24-hour period is calculated from the following equation:

$$REC_{RI} = PEC + (24 - t_{\text{def}}) \times (\Phi_{24\text{-def}} + 0,5PEC \frac{(T_c - T_{\text{mrun}})}{(0,34 T_{\text{mrun}})})$$

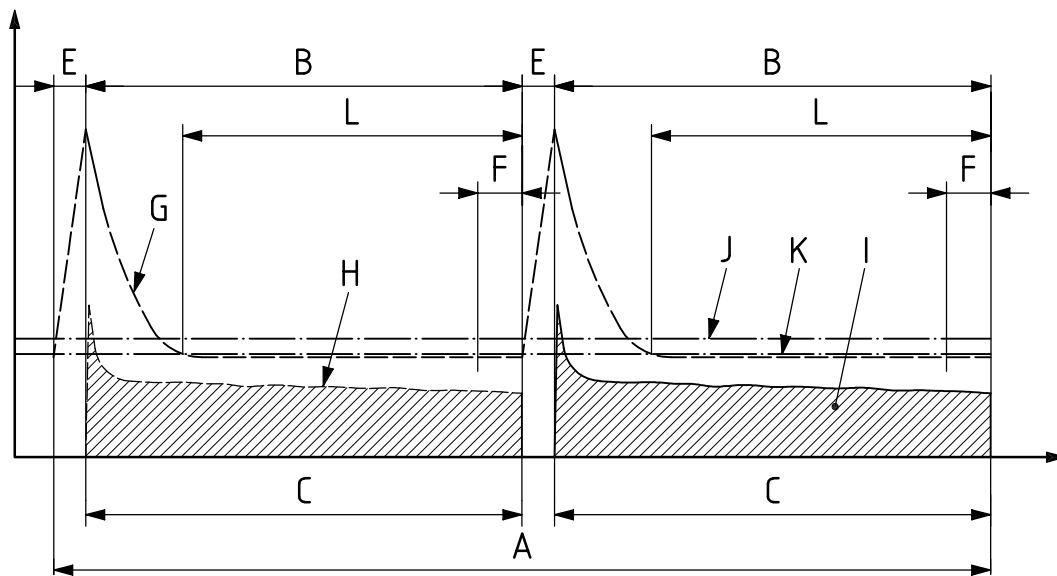
with a constant condensing temperature of $T_c = 308,15 \text{ K}$ ($35 \text{ }^\circ\text{C}$).

NOTE For both direct and indirect systems, the calculated energy consumption refers to a standard refrigeration plant. Although the actual energy consumption of a refrigeration plant is generally not equal to that of the standard plant, it can be mathematically proven that the “ranking order” of cabinets remains the same.

5.3.6.3.4 Calculation of TEC

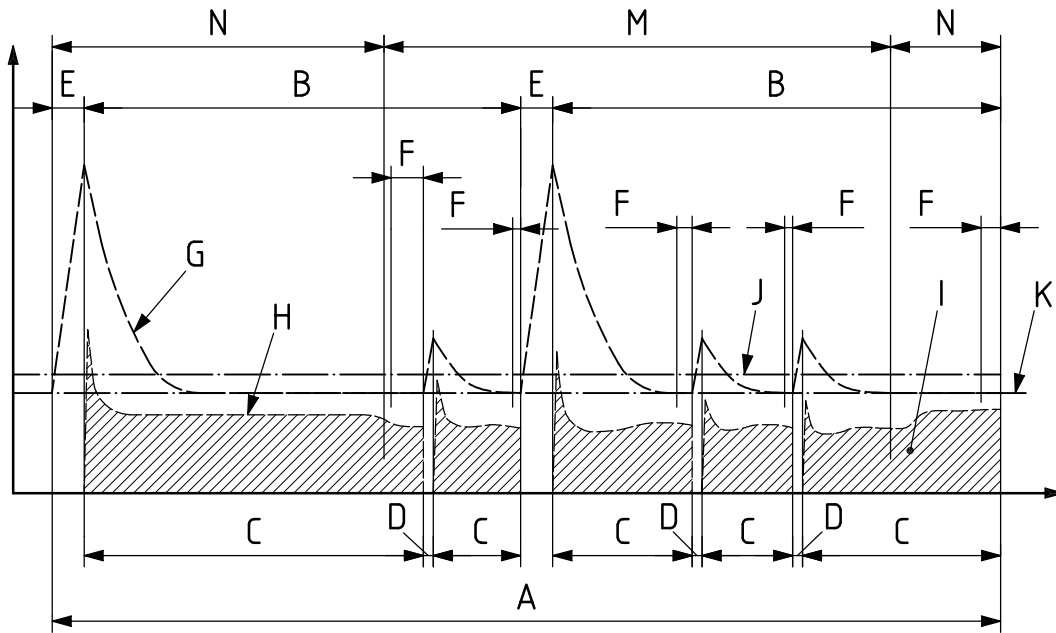
The total energy consumption is calculated from the equation:

$$TEC = DEC + REC$$



a) Constant evaporating pressure, no cycling

Figure 30 — Refrigeration cycle — Constant evaporating pressure — No cycling

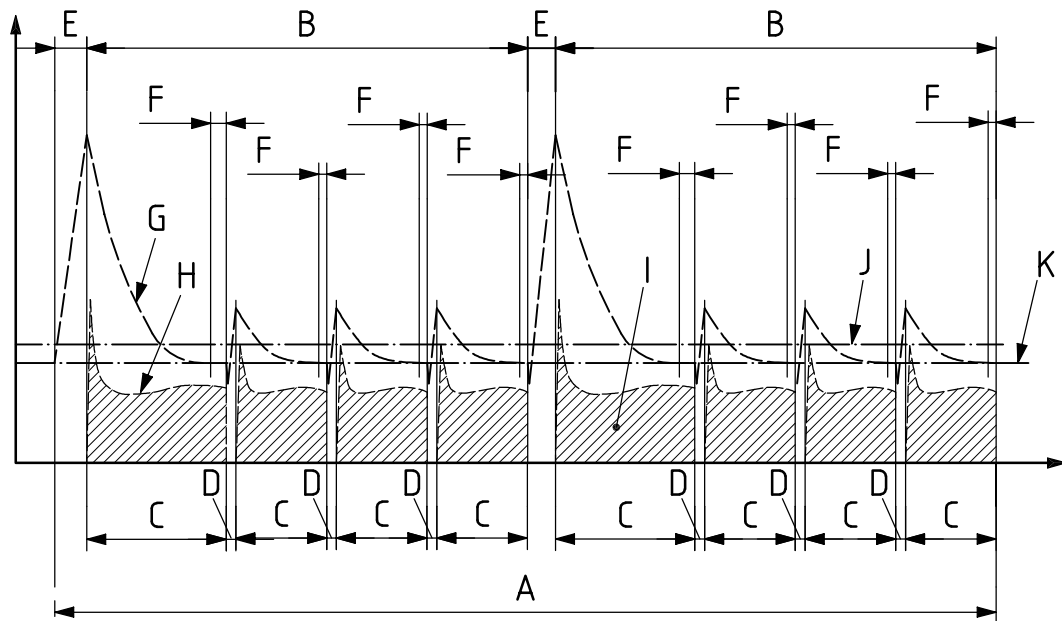


b) Constant evaporating pressure, no cycling, and cycling with night covers on

Key

- A 24 h (ref.)
- B refrigerating period (ref.)
- C running time (t_{run})
- D off time (t_{stop})
- E defrost off period (t_{defst})
- F running time for reporting evaporating temperature ($t_{run} \cdot 10\%$)
- G evaporating temperature
- H instant heat extraction rate (ϕ_n)
- I extraction rate (Q_{tot} = area under graph)
- J average of evaporator saturated temperature (θ_{mrun})
- K average of evaporator saturated temperature during last 10% of running periods (θ_{min})
- L 75% of running time between defrosts ($t_{run} \cdot 75\%$)
- M night covers on 12 h
- N night covers off 12 h

Figure 30 (continued)

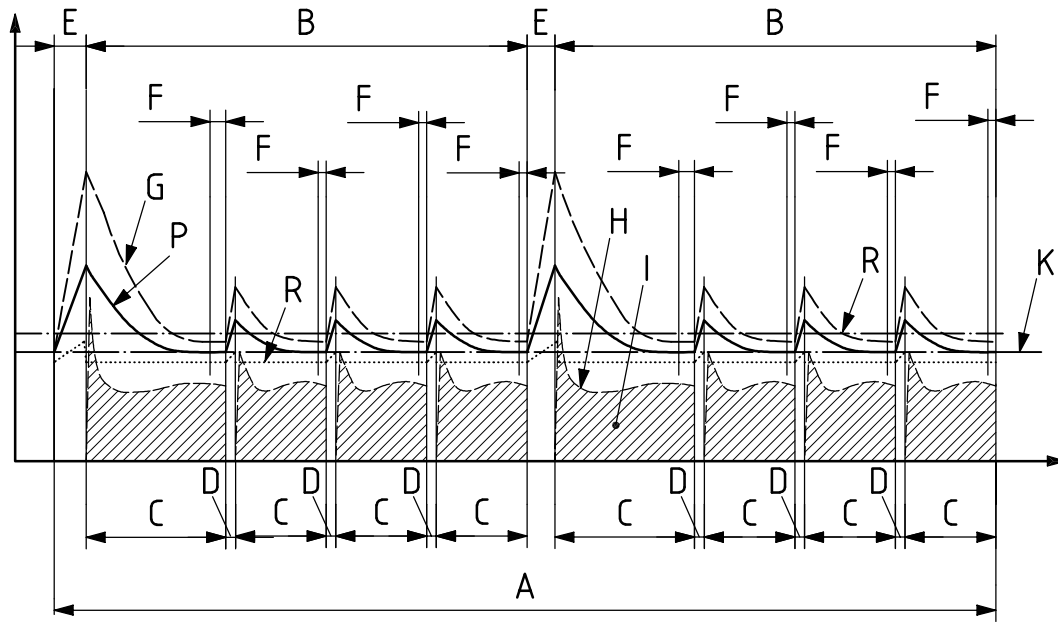


Key

- A 24 h (ref.)
- B refrigerating period (ref.)
- C running time (t_{run})
- D off time (t_{stop})
- E defrost off period (t_{defl})
- F running time for reporting evaporating temperature ($t_{run} \cdot 10\%$)
- G evaporating temperature
- H instant heat extraction rate (Φ_n)
- I extraction rate ($Q_{tot} = \text{area under graph}$)
- J average of evaporator saturated temperature (θ_{mrun})
- K average of evaporator saturated temperature during last 10 % of running periods (θ_{min})

Figure 31 — Refrigeration cycle — Cycling including pump down

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Key

- A 24 h (ref.)
- B refrigerating period (ref.)
- C running time (t_{run})
- D off time (t_{stop})
- E defrost off period (t_{defl})
- F running time for reporting evaporating temperature ($t_{run} \cdot 10\%$)
- G secondary refrigerant outlet temperature (θ_o)
- H instant heat extraction rate (Φ_n)
- I extraction rate ($Q_{tot} = \text{area under graph}$)
- O secondary refrigerant inlet temperature (θ_i)
- P secondary refrigerant median temperature (θ)
- R average of secondary refrigerant median temperature (θ_{mrun})
- S average of secondary refrigerant median temperature during last 10% of running periods (θ_{min})

Figure 32 — Refrigeration cycle with secondary refrigerant with cycling

6 Test report

6.1 General

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

NOTE For information to be given on the cabinet, see 7.2.

6.2 Tests outside test room

6.2.1 Seal test of doors and lids

According to 5.2.1.

That the doors or lids seal effectively.

6.2.2 Linear dimensions, areas and volumes

According to 5.2.2.

See Table 7.

Table 7 — Linear dimensions, areas and volumes

Description	Symbol	Unit	Number of decimal places
Overall external dimensions at installation	L, H, W	mm	0
Overall external dimensions in service		mm	0
Refrigerated shelf area for each declared temperature class		m ²	2
Display opening area		m ²	2
Total display area	TDA	m ²	2
Visibility of foodstuffs (optional)	VPA	m ²	2
Net volume for each declared temperature class		l	0
		m ³	3
Sneeze guard, see Figure 1	<i>A + B</i>	mm	0

6.2.3 Test for absence of odour and taste (if applicable)

See Annex D.

6.3 Tests inside test room

6.3.1 General test conditions

According to 5.3.1.

See Table 8.

Table 8 — Conditions for tests inside test room

Subclause no.	Description
5.3.1.1	Statement that the test room, test packages, filling material (wood loading), M-packages and the instrumentation used are in accordance with 5.3.1
5.3.1.2	Test room climate class for which the cabinet is intended and in which the test has been made

6.3.2 Cabinet preparation

See Table 9.

Table 9 — Cabinet preparation for tests inside test room

Subclause no.	Description	Symbol	Unit
5.3.2.1	The cabinet location within the test room using the Figure 9 presentation	X, B, Y, A	mm
5.3.2.2	For cabinets intended to be placed against a wall, the location of the vertical partition at the rear of the cabinet	d_p	mm
5.3.2.3	Number of the figure according to which the cabinet was loaded		
5.3.2.4	The method of temperature control, defrost process, defrost termination, setting parameters and sensor locations		
5.3.2.5	Whether the test was made with or without night-covers and/or light		
5.3.2.6	When the condensing unit is remote from the cabinet for compression-type refrigerating systems the international number of the refrigerant (see ISO 817)		
5.3.2.7	When the condensing unit is remote from the cabinet for indirect-type refrigerating systems:		
	chemical composition of the secondary refrigerant		
	concentration of the secondary refrigerant		
	The physical properties of the secondary refrigerant:		
	specific heat at the cabinet inlet/outlet	c_i/c_o	kJ/kg/°C
	density	ρ	kg/m ³

6.3.3 Temperature test

According to 5.3.3.

See Table 10.

Table 10 — Temperature test for tests inside test room

Subclause no.	Description	Symbol	Unit
5.3.3.1	For cabinets fitted with night-covers and/or lights, if the results are for the “first” or the “second” test of 5.3.2.7 or for both tests (two sets of results shall be provided for the latter case)		
5.3.3.2	The time/temperature curves of the warmest and the coldest M-packages and the extreme values θ_{ah} , θ_b and if necessary θ_{al} and the resulting cabinet classification (see 5.3.3.4 and Figure 25)	θ_{ah} θ_b θ_{al}	°C
5.3.3.3	The average mean temperatures of all M-packages (see also 5.3.3.5 and Figure 26)		°C
5.3.3.4	For temperature display systems, the sensor location and the maximum values displayed		
	under stable operating conditions		°C
	at the warmest moment, during or just after the defrost period		°C
	Conditions where the display of temperature may be interrupted (e.g., during defrosting)		
5.3.3.5	The results from defrost check according to 5.3.3.3		

6.3.4 Water vapour condensation test

According to 5.3.4.

See Table 11.

Table 11 — Water vapour condensation test

Subclause no.	Description	Symbol	Unit
5.3.4.1	For cabinets fitted with night-covers and/or lights, state whether the results are for the “first” or the “second” test of 5.3.2.7 or for both tests. Two sets of results shall be provided in the latter case		
5.3.4.2	Whether any manual switch provided for anti-condensation heaters was switched off		
5.3.4.3	The duration of the period of observation		h
	Coded sketches as defined in 5.3.4.3		

6.3.5 Electrical energy consumption test

According to 5.3.5.

See Table 12.

Table 12 — Electrical energy consumption test

Subclause no.	Description	Symbol	Unit
5.3.5.1	For cabinets fitted with night-covers and/or lights, state whether the results are for the “first” or the “second” test of 5.3.2.7 or for both tests. Two sets of results shall be provided in the latter case		
5.3.5.2	For cabinets fitted with integral condensing unit:		
	direct electrical energy consumption (= total electrical energy consumption)	<i>DEC</i> <i>(TEC)</i>	kWh/24 h
	compressor switching on/off frequency		
	relative running time		
5.3.5.3	For cabinets with remote condensing unit:		
	direct electrical energy consumption	<i>DEC</i>	kWh/24 h

6.3.6 Heat extraction rate measurement when the condensing unit is remote from the cabinet

According to 5.3.6.

See Table 13.

Table 13 — Heat extraction rate measurement when the condensing unit is remote from the cabinet

Subclause no.	Description	Symbol	Unit
5.3.6.1	For cabinets fitted with night-covers and/or lights, state whether the results are for the "first" or the "second" test of 5.3.2.7 or for both tests. Two sets of results shall be provided in the latter case		
5.3.6.2.1	For compression-type refrigerating systems:		
See Figures 28, 30 and 31	curves and mean values of the suction pressure, in service, and the refrigerant temperature at the cabinet outlet	p_8 θ_8	Pa °C
	mean value of the saturated evaporator temperature during the running time and during the last 10 % of all running periods	θ_{mrun} θ_{min}	°C °C
	arithmetic mean suction superheat at the cabinet outlet		°C
	arithmetic mean suction superheat at the evaporator outlet		°C
	curve and mean value of the liquid temperature at the cabinet inlet	θ_4	°C
	curve and mean value of the mass flow rate of refrigerant	q_m	kg/s
5.3.6.2.2	For indirect refrigerating systems:		
See Figures 29 and 32	curve and mean value of the secondary refrigerant temperature at the cabinet inlet	θ_i	°C
	curve and mean value of the secondary refrigerant temperature at the cabinet outlet	θ_o	°C
	mean value of the median temperature of the secondary refrigerant during the running time	θ_{mrun}	°C
	mean value of the median temperature of the secondary refrigerant during the last 10 % of all running periods	θ_{min}	°C
	curve and mean value of the mass flow rate	q_m	kg/s
	pressure drop between the inlet and outlet of the cabinet excluding valves not fitted by the manufacturer as part of the cabinet	$p_{irun} - p_{orun}$	Pa
5.3.6.3	Heat extraction rates necessary for the cabinet which result from the foregoing measurements:		
		Φ_{run}	kW
		Φ_{run75}	kW
		Φ_{24}	kW
		$\Phi_{24-defr}$	kW
	refrigeration electrical energy consumption	REC	kWh/24 h
	total energy consumption	TEC	kWh/24 h
	for cabinets where cycling of the system is necessary for operational reasons, the percentage running time	t_{rr}	%

7 Marking

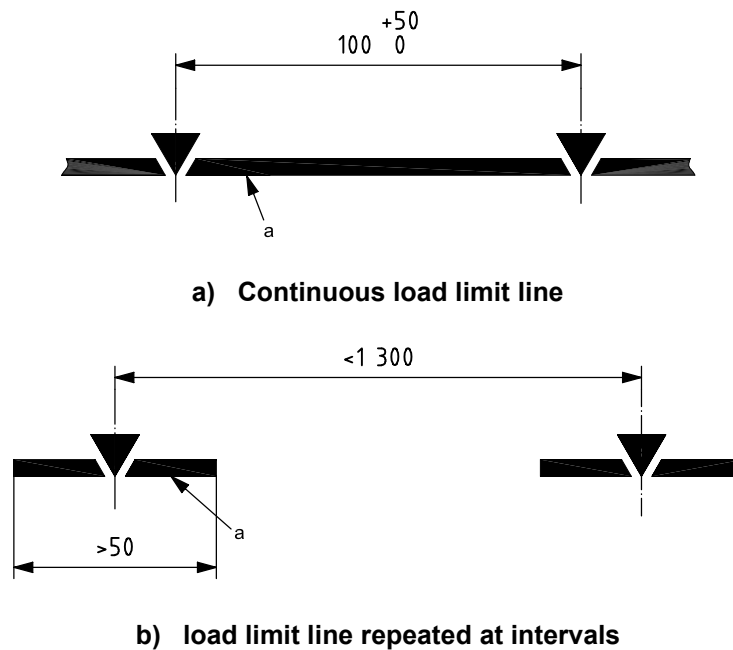
7.1 Load limit

Every cabinet shall be clearly and permanently marked with one or several load limit line(s) [see Figure 33 b)], on the inside face, as shown in Figure 35, 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 33 a)], or repeated at intervals [Figure 33 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_1 , included within 5,5 mm and 15 mm (see Figure 34).

Where a load limit line cannot be marked because of cabinet design, an outline sketch showing the load limit shall be fixed in a visible position.

Dimensions in millimetres



a This denotes the load limit.

Figure 33 — Load limit markings

Dimensions in millimetres

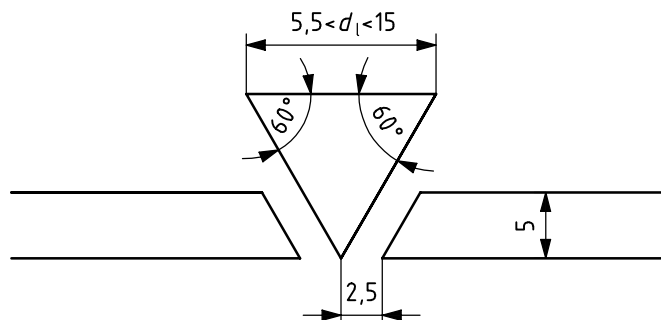


Figure 34 — Dimensions of load limit line

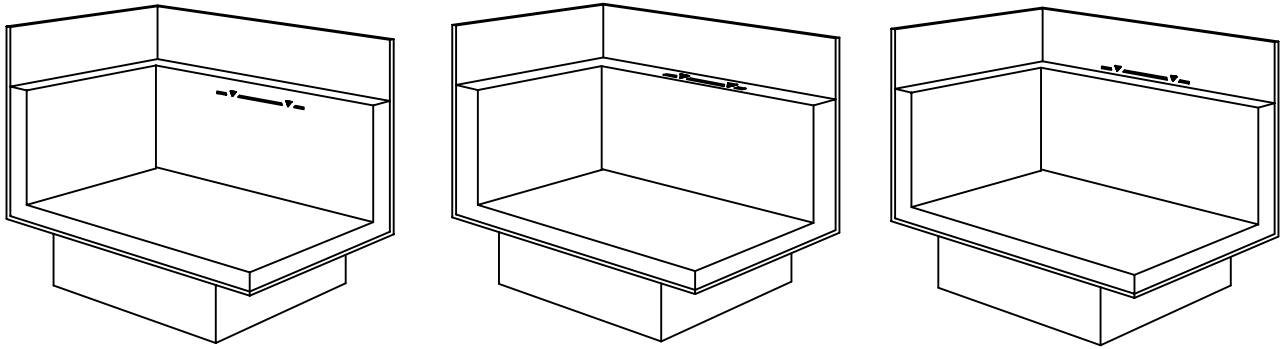


Figure 35 — Different positions for the load limit

7.2 Marking plate

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

- a) the manufacturer's name or trademark or both (not necessarily the same name as that of the condensing unit);
- b) model and serial number of the cabinet, integral condensing unit(s), etc., or sufficient information to provide adequate identification for replacement of parts or necessary servicing;
- c) a description of the cabinet's internal fittings;
- d) all information relating to the power supply for which the cabinet is designed;
- e) for cabinets with integral condensing unit, the international number of refrigerant(s) (see ISO 817) used and its (their) mass;
- f) for cabinets having remote condensing units, marking in accordance with EN 378-2.

7.3 Information to be supplied by the manufacturer

The following information shall be provided by the manufacturer with each cabinet.

- a) Overall external dimensions at installation.
- b) Overall external dimensions in service.
- c) For each indicated cabinet class (see 4.2.2):
 - 1) the display opening area;
 - 2) total display area (see Annex A);
 - 3) visibility of foodstuffs (see Annex B), (optional);
 - 4) the net volume;
 - 5) where applicable, the refrigerated shelf area;
 - 6) the maximum load, in kilograms, permitted on the trays and shelves and in the baskets or on the base deck for the various methods of arranging them in the cabinet;

- 7) for cabinets fitted with night-covers and/or lights, if the results are for the “first” or the “second” test of 5.3.2.7 or for both tests, in the latter case with two sets of information being provided for
- i) the electrical energy consumption (DEC), in kilowatt hours per 24 h, measured in accordance with the test described in 5.3.5, and
 - ii) if the condensing unit is not fitted in the refrigerated cabinet, the information referred to heat extraction rate according to 5.3.6.

NOTE For temperature and climate classes, see 4.2.2 and 5.3.1.3.1.

- d) For each temperature class in which the refrigerated display cabinets operate, the manufacturer shall furnish the following temperature display information, according to the measuring results in the test (see 5.3.2):
- 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
(normative)

Total display area (TDA)

A.1 General

The TDA is determined by the sum of vertical and horizontal projected areas from visible foodstuff, in square metres. For multi-deck and semi-vertical cabinets, the horizontal projected area is measured from a plane located at 1,55 m from the ground in order to take into account the visible foodstuffs located in the front part of the shelves (see Figure A.3).

A.2 Measurement of TDA in a refrigerated display cabinet

A.2.1 General conditions

Where foodstuffs are visible through a glazed surface, the light transmission, T_g , shall be taken into account according to the values defined in Table A.1:

Table A.1 — Light transmission

Type of glazed surface	T_g
Single anti-reflection glass	98 %
Single glass	90 %
Double glass or two single glasses	81 %
Triple glass without coating	73 %
Specific glass with reflective or heated face(s)	Value obtained by measurement according to ISO 9050

The opaque areas of the frames or hand rails shall be deducted from the measurement.

A.2.2 Calculation of TDA

The total display area shall be calculated as follows:

$$TDA = (H_o \times L_{oh}) + (H_g \times T_{gh} \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times T_{gv} \times L_{gv})$$

where

H is the horizontal projection, in metres;

V is the vertical projection, in metres;

L is the cabinet length without end walls, in metres;

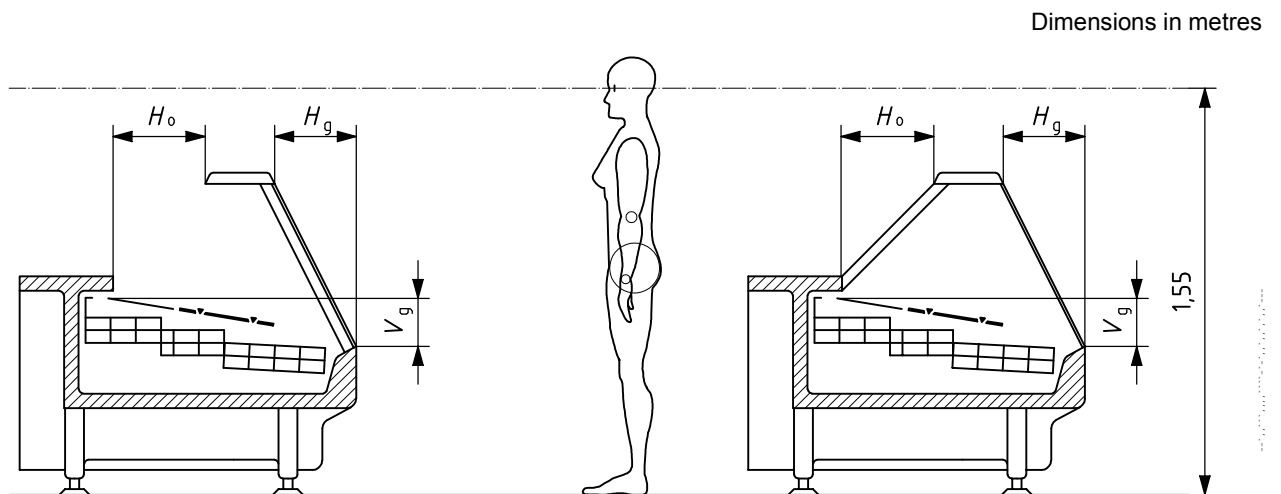
T_g is the light transmission through the glazing surface;

D is the depth (side view on wall of end cabinets);

- index o is the open surface;
- index g is the glazing surface;
- index h is the horizontal;
- index v is the vertical;
- index w is the end wall.

NOTE As an example, the glazing surface may be different for the front (T_{gv}) and for the lid (T_{gh}).

Figures A.1 to A.9 illustrate the calculation for the most common cabinets with a length of 2,5 m.



	$L_{oh} = 2,500$	$H_o = 0,350$
$T_{gh} = 90 \%$	$L_{gh} = 2,400$	$H_g = 0,194$
	$L_{ov} = 2,500$	$V_o = 0$
$T_{gv} = 90 \%$	$L_{gv} = 2,400$	$V_g = 0,185$

	$L_{oh} = 2,400$	$H_o = 0,350$
$T_{gh} = 90 \%$	$L_{gh} = 2,500$	$H_g = 0,194$
	$L_{ov} = 2,500$	$V_o = 0$
$T_{gv} = 90 \%$	$L_{gv} = 2,500$	$V_g = 0,185$

$TDA = (H_o \times L_{oh}) + (H_g \times T_{gh} \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times T_{gv} \times L_{gv})$	1,694
---	-------

$TDA = (H_o \times L_{oh}) + (H_g \times T_{gh} \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times T_{gv} \times L_{gv})$	1,693
---	-------

Figure A.1 — Horizontal, chilled, serve-over counters

Dimensions in metres

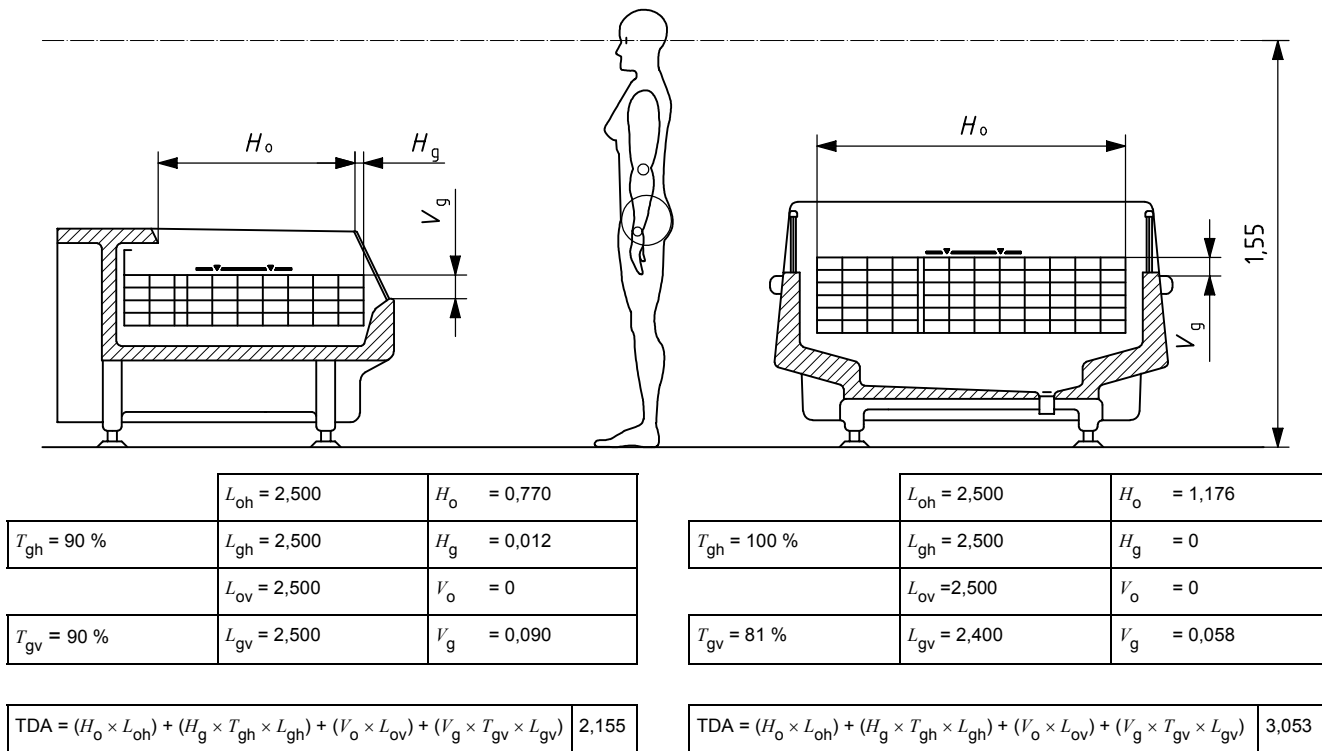


Figure A.2 — Horizontal, chilled, open, wall-site and island cabinets

Dimensions in metres

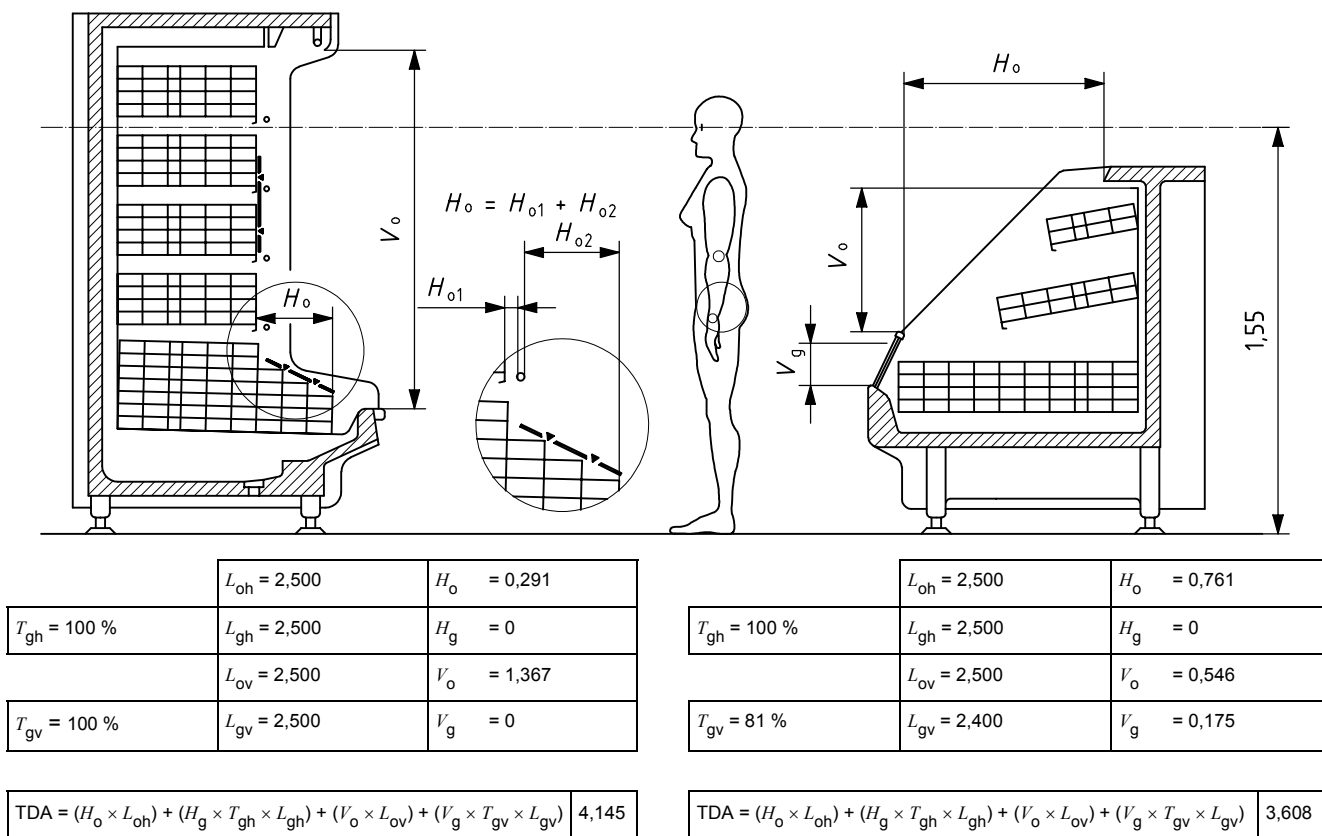
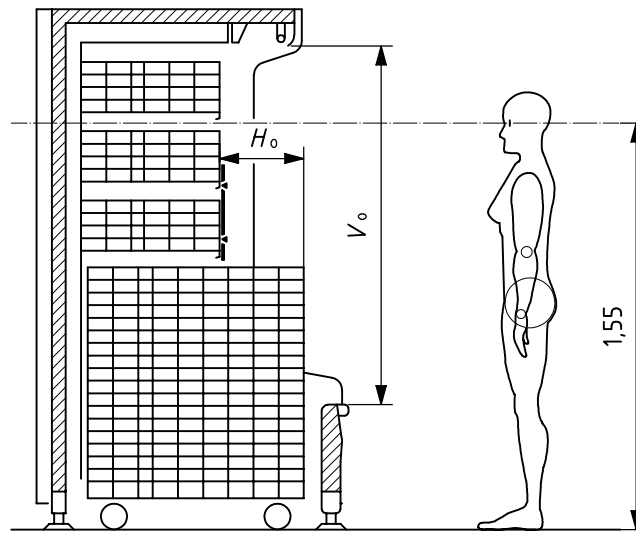


Figure A.3 — Vertical, chilled, multi-deck and semi-vertical cabinets

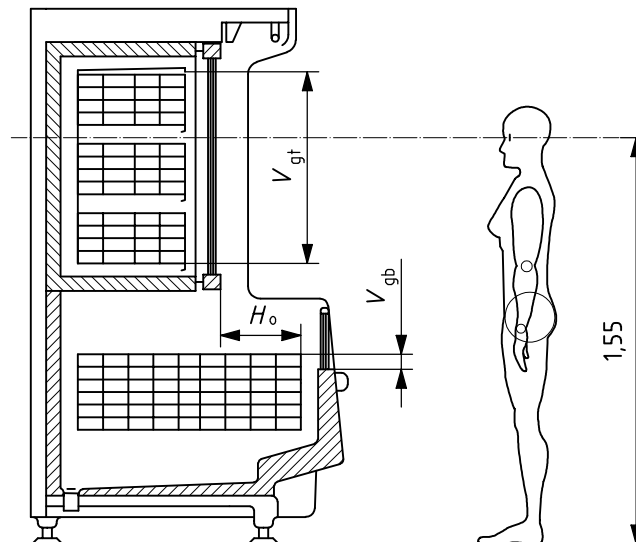
Dimensions in metres



	$L_{oh} = 2,500$	$H_o = 0,321$	
$T_{gh} = 100\%$	$L_{gh} = 2,500$	$H_g = 0$	
	$L_{ov} = 2,500$	$V_o = 1,367$	
$T_{gv} = 100\%$	$L_{gv} = 2,500$	$V_g = 0$	
$TDA = (H_o \times L_{oh}) + (H_g \times T_{gh} \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times T_{gv} \times L_{gv})$			4,220

Figure A.4 — Vertical, chilled, roll-in cabinet

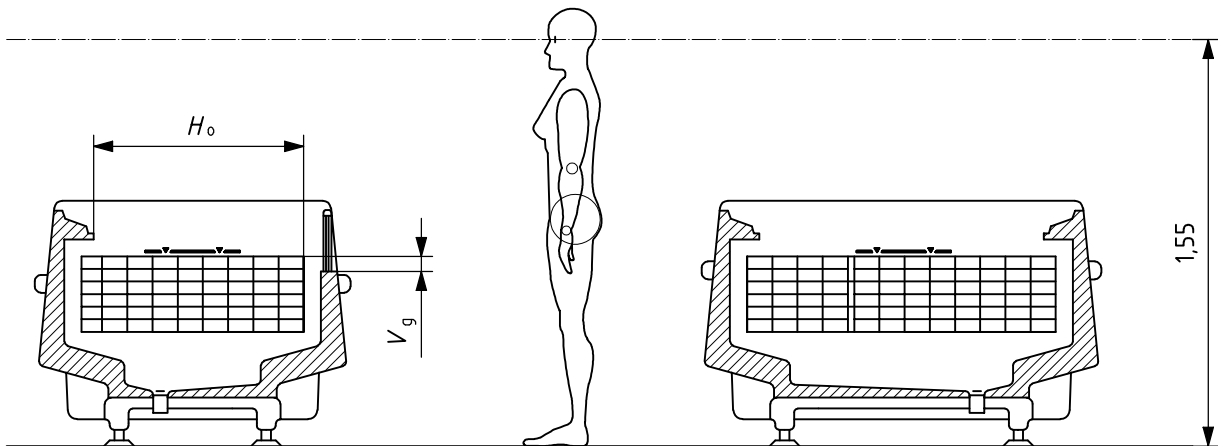
Dimensions in metres



	$L_{oh} = 2,500$	$H_o = 0,306$	
$T_{gh} = 100\%$	$L_{gh} = 2,500$	$H_g = 0$	
	$L_{ov} = 2,500$	$V_o = 0$	
$T_{gvt} = 73\%$	$L_{gv} = 2,250$	$V_{gvt} = 0,731$	
$T_{gvb} = 73\%$	$L_{gv} = 2,400$	$V_{gvb} = 0,058$	
$TDA = (H_o \times L_{oh}) + (H_g \times T_{gh} \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times T_{gv} \times L_{gv})$			2,067

Figure A.5 — Combined, frozen, glass door top, open bottom, cabinet

Dimensions in metres



	$L_{oh} = 2,500$	$H_o = 0,800$
$T_{gh} = 100\%$	$L_{gh} = 2,500$	$H_g = 0$
	$L_{ov} = 2,500$	$V_o = 0$
$T_{gv} = 73\%$	$L_{gv} = 2,400$	$V_g = 0,058$

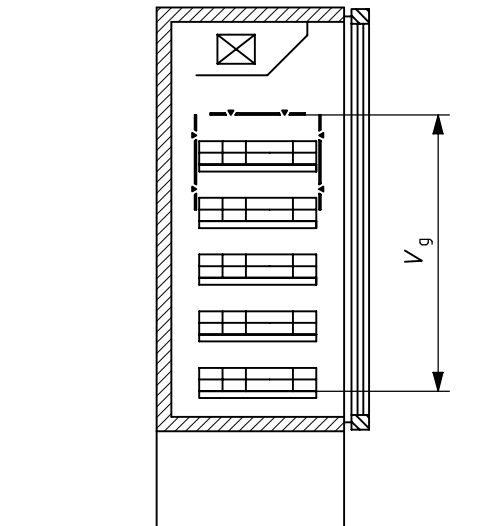
	$L_{oh} = 2,500$	$H_o = 1,084$
$T_{gh} = 100\%$	$L_{gh} = 2,500$	$H_g = 0$
	$L_{ov} = 2,500$	$V_o = 0$
$T_{gv} = 100\%$	$L_{gv} = 2,500$	$V_g = 0$

$TDA = (H_o \times L_{oh}) + (H_g \times T_{gh} \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times T_{gv} \times L_{gv})$	2,102
---	-------

$TDA = (H_o \times L_{oh}) + (H_g \times T_{gh} \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times T_{gv} \times L_{gv})$	2,710
---	-------

Figure A.6 — Horizontal, frozen, open, island cabinets

Dimensions in metres

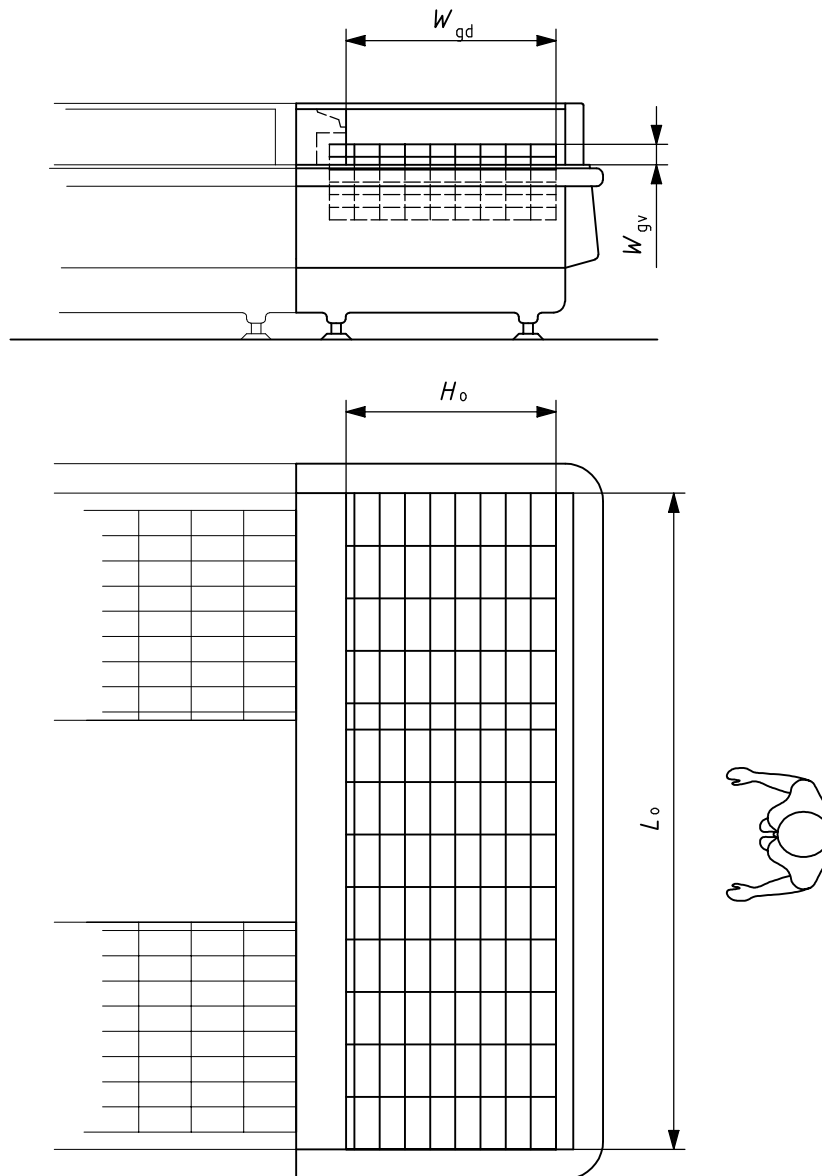


	$L_{oh} = 2,500$	$H_o = 0$
$T_{gh} = 100\%$	$L_{gh} = 2,500$	$H_g = 0$
	$L_{ov} = 2,500$	$V_o = 0$
$T_{gv} = 64\%$	$L_{gv} = 2,250$	$V_g = 1,053$

$TDA = (H_o \times L_{oh}) + (H_g \times T_{gh} \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times T_{gv} \times L_{gv})$	1,516
---	-------

Figure A.7 — Vertical, frozen, glass door, cabinet

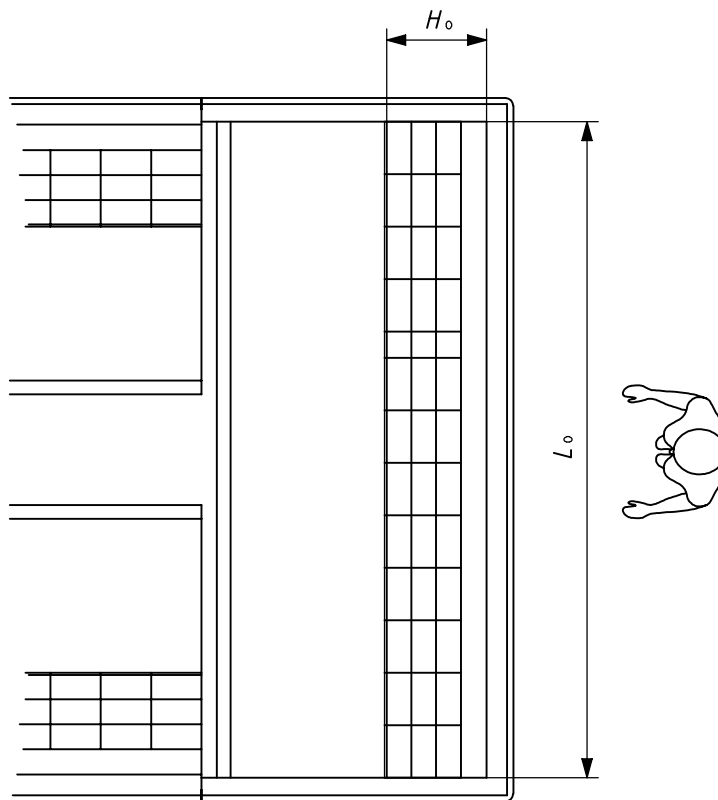
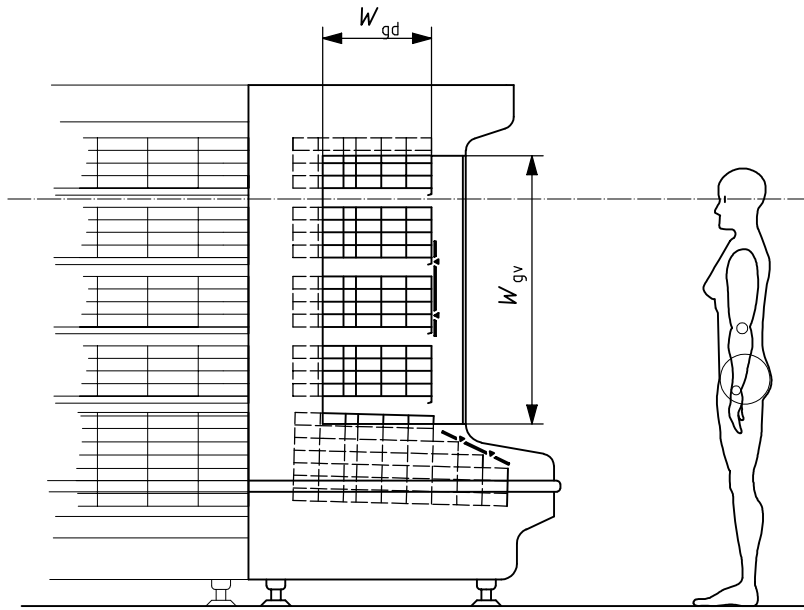
Dimensions in metres



	$L_{oh} = 2,500$	$H_o = 0,800$
$T_{gh} = 100\%$	$L_{gh} = 2,500$	$H_g = 0$
	$L_{ov} = 2,500$	$V_o = 0$
$T_{gv} = 73\%$	$L_{gv} = 2,400$	$V_g = 0,058$
$T_{gw} = 73\%$	$W_{gv} = 0,058$	$W_{gd} = 0,800$

$TDA = (H_o \times L_{oh}) + (H_g \times T_{gh} \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times T_{gv} \times L_{gv}) + (T_{gw} \times V_{gw} \times D_{gw})$	2,135
--	-------

Figure A.8 — Horizontal, frozen, open, island end cabinet



	$L_{oh} = 2,500$	$H_o = 0,291$
$T_{gh} = 100\%$	$L_{gh} = 2,500$	$H_g = 0$
	$L_{ov} = 2,500$	$V_o = 1,367$
$T_{gv} = 100\%$	$L_{gv} = 2,500$	$V_g = 0$
$T_{gw} = 81\%$	$W_{gv} = 1,022$	$W_{gd} = 0,415$
$TDA = (H_o \times L_{oh}) + (H_g \times T_{gh} \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times T_{gv} \times L_{gv}) + (T_{gw} \times V_{gw} \times D_{gw})$		4,489

Figure A.9 — Vertical, chilled, multi-deck end cabinet

Annex B (normative)

Visibility of products by Arc method (VPA)

B.1 Terms and definitions

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

B.1.1 visibility of products by the arc method

VPA

parameter in square meters determined by multiplying the length of the arc, defined by the arc method, with the visible length of the foodstuffs

B.1.2 arc method

measurement method using the length of the arc ($R = 1,6$ m) defined within the angle of vision of a consumer's eye at a height of 1,55 m in relation to the ground and 1 m in front of the bumper

B.2 Measurement of VPA in a refrigerated display cabinet

B.2.1 General conditions

Where foodstuffs are visible through a glazed surface, the light transmission, T_g , shall be taken into account according to the values defined in Table B.1:

Table B.1 — Light transmission

Type of glazed surface	T_g
Single anti-reflection glass	98 %
Single glass	90 %
Double glass or two single glasses	81 %
Triple glass without coating	73 %
Specific glass with reflective or heated face(s)	Value obtained by measurement according to ISO 9050

The opaque areas of the frames or hand rails shall be deducted from the measurement.

B.2.2 Calculation of VPA

The visibility of foodstuffs shall be calculated by the arc method as follows:

$$VPA = (A_o \times L_o) + (T_g \times A_g \times L_g)$$

where

A is the length of the arc, in metres;

L is the cabinet length without end walls, in metres;

T_g is the light transmission through the glazing surface;

D is the depth (side view on wall of end cabinets);

index o is the open surface;

index g is the glazing surface;

index h is the horizontal;

index v is the vertical;

index t is the top;

index b is the bottom;

index w is the end wall.

NOTE As an example, the glazing surface may be different for the front (T_{gv}) and for the lid (T_{gh}).

Figures B.1 to B.5 illustrate the calculation for the most common cabinets with a length of 2,5 m.

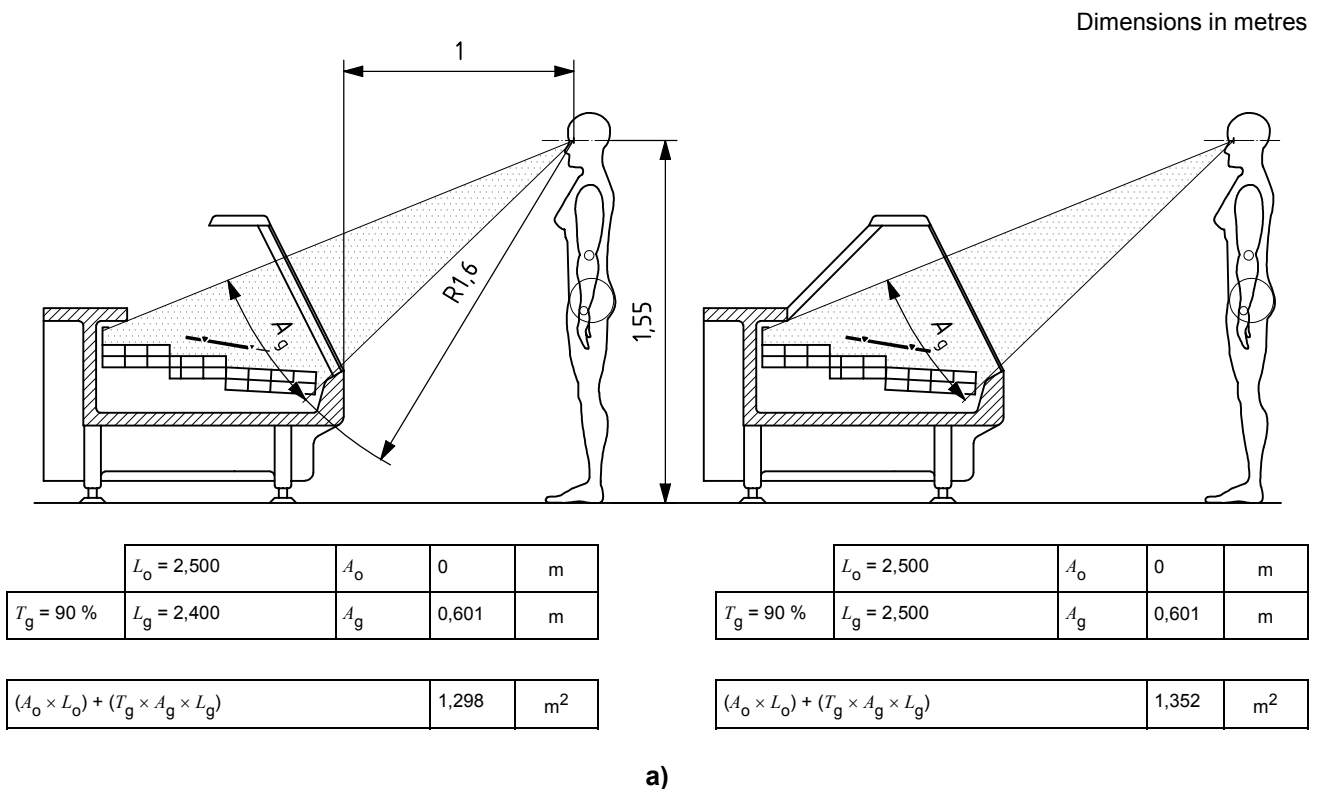
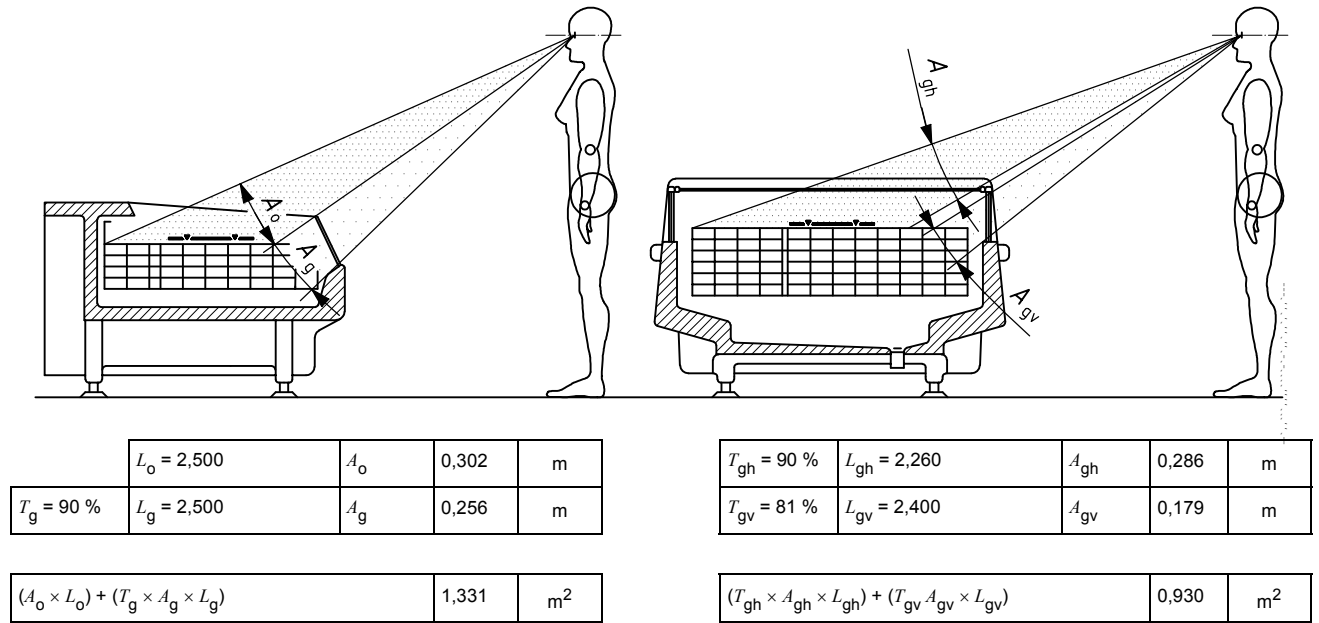
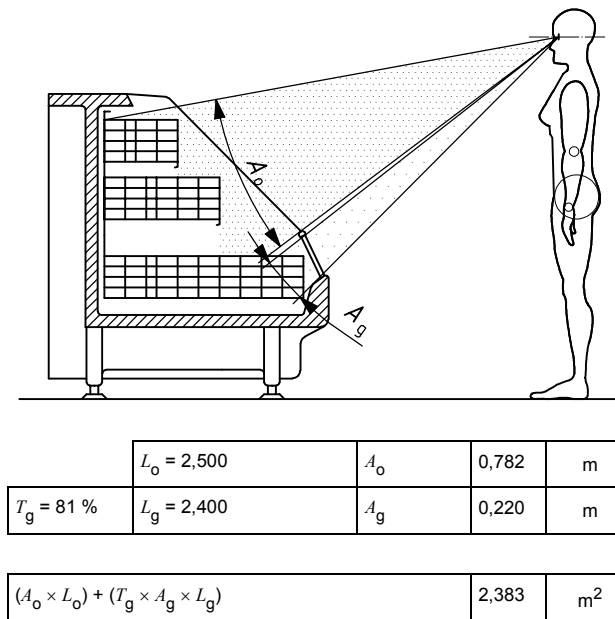


Figure B.1 — Calculation of VPA on horizontal serve-over counters and horizontal open wall-site and island cabinets



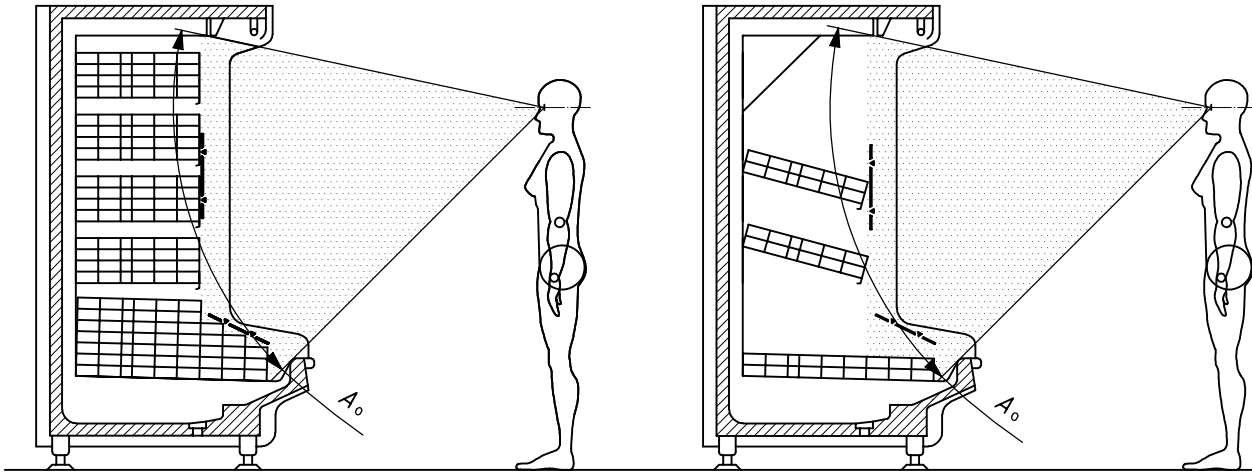
b)

Figure B.1 (continued)



a)

Figure B.2 — Calculation of VPA on self-service cabinets: semi-vertical cabinets, multi-deck cabinets, roll-in cabinets, glass door cabinets



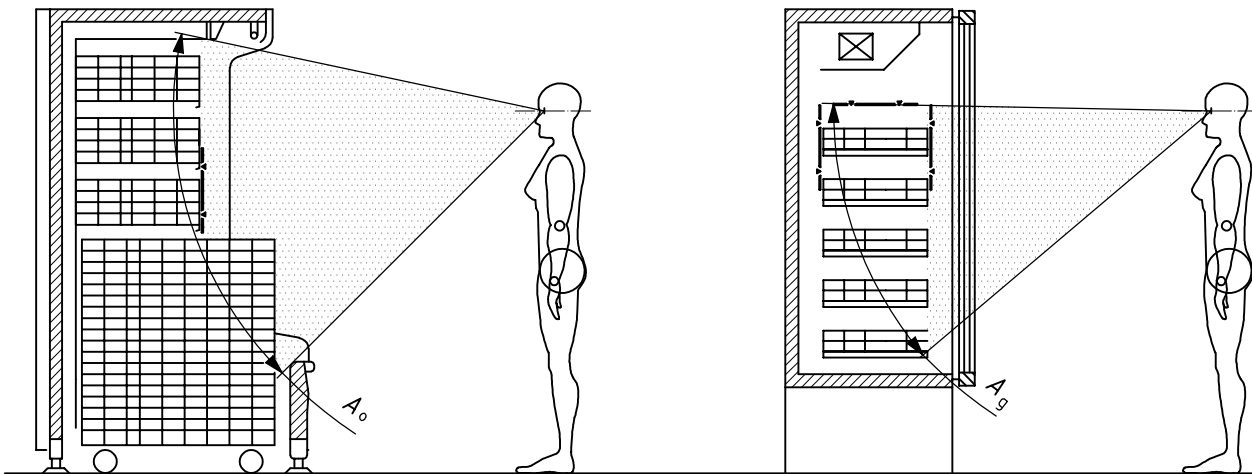
	$L_o = 2,500$	A_o	1,544	m
$T_g = 100\%$	$L_g = 2,500$	A_g	0	m

$(A_o \times L_o) + (T_g \times A_g \times L_g)$			3,860	m^2
--	--	--	-------	-------

	$L_o = 2,500$	A_o	1,544	m
$T_g = 100\%$	$L_g = 2,500$	A_g	0	m

$(A_o \times L_o) + (T_g \times A_g \times L_g)$			3,860	m^2
--	--	--	-------	-------

b)



	$L_o = 2,500$	A_o	1,555	m
$T_g = 100\%$	$L_g = 2,500$	A_g	0	m

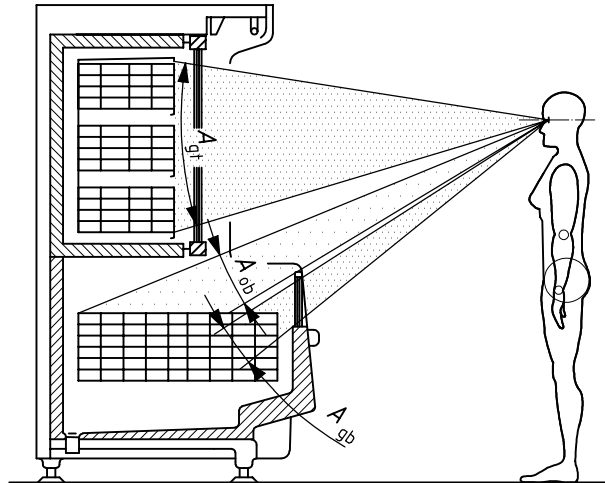
$(A_o \times L_o) + (T_g \times A_g \times L_g)$			3,888	m^2
--	--	--	-------	-------

	$L_o = 2,500$	A_o	0	m
$T_g = 64\%$	$L_g = 2,250$	A_g	1,187	m

$(A_o \times L_o) + (T_g \times A_g \times L_g)$			1,709	m^2
--	--	--	-------	-------

c)

Figure B.2 (continued)



	$L_{ot} = 2,500$	A_{ot}	0	m
$T_{gt} = 73 \%$	$L_{gt} = 2,250$	A_{gt}	0,707	m
	$L_{ob} = 2,500$	A_{ob}	0,236	m
$T_{gb} = 73 \%$	$L_{gb} = 2,400$	A_{gb}	0,179	m
$(A_{ot} \times L_{ot}) + (T_{gt} \times A_{gt} \times L_{gt}) + (A_{ob} \times L_{ob}) + (T_{gb} \times A_{gb} \times L_{gb})$			2,065	m ²

Figure B.3 — Calculation of VPA on self-service combined cabinets

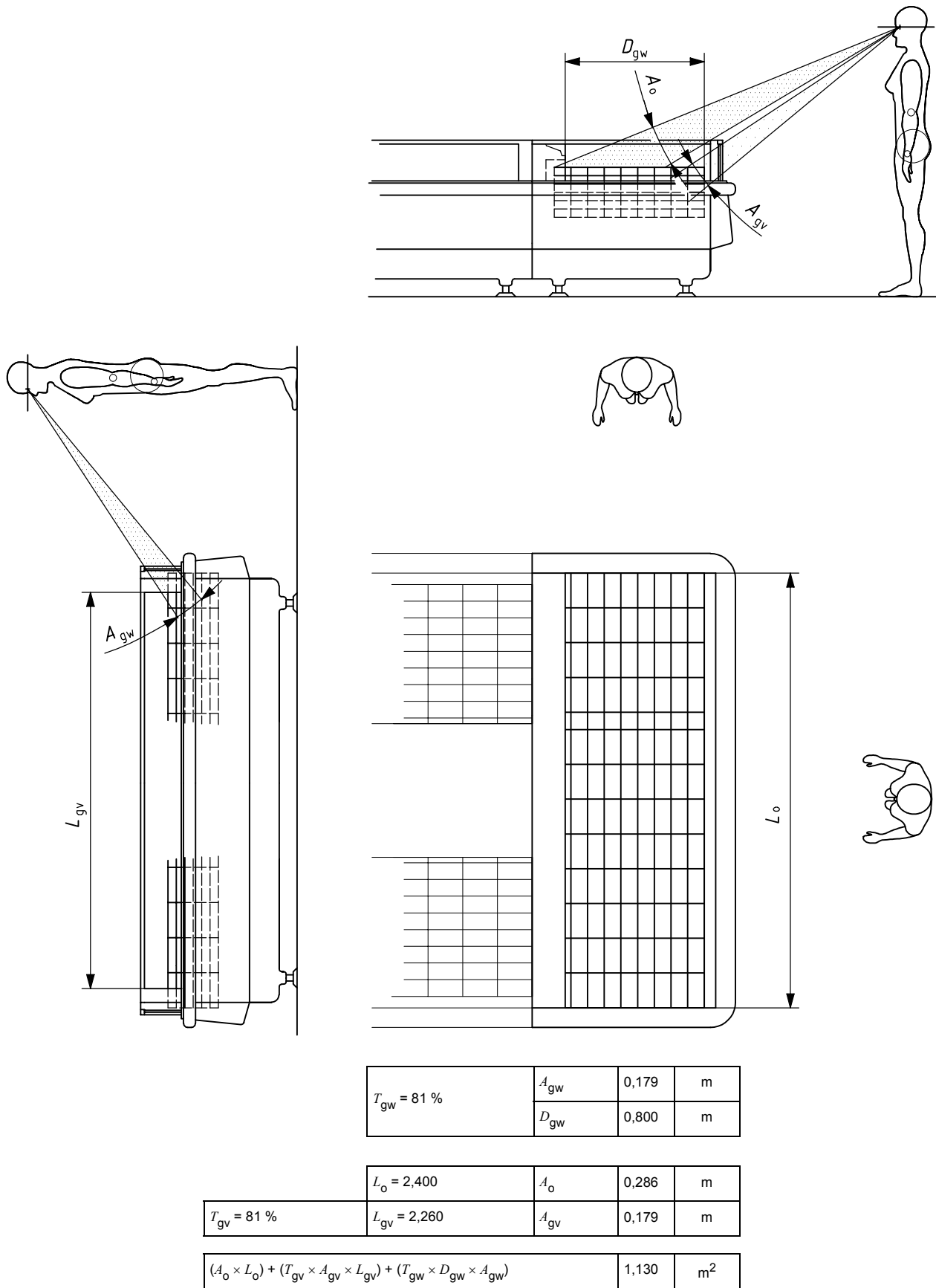


Figure B.4 — Calculation of VPA for horizontal, frozen, open, island end cabinets

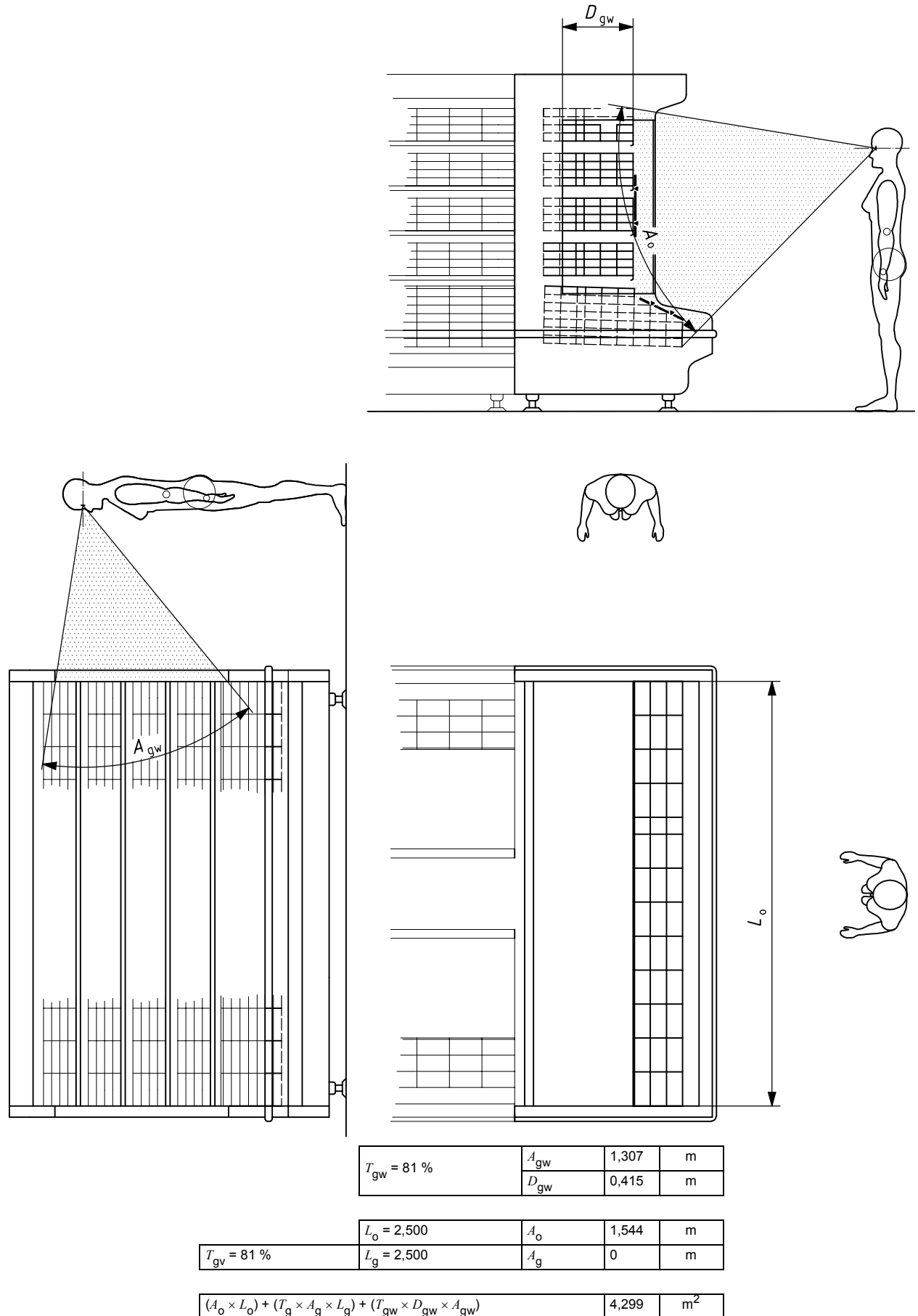


Figure B.5 — Calculation of VPA for vertical, chilled, multi-deck end cabinets

Annex C
(informative)

Comparison between laboratory and in-store conditions

The complete range of various climate conditions and various ways of loading in stores cannot be simulated in the laboratory. For these reasons, specific climate classes and loading are defined for tests in the laboratory to classify cabinets and to make comparisons.

For open refrigerated display cabinets, test results in laboratory cannot be directly transposed in stores.

	Laboratory	In-store
The reference is defined by:	En 23953	The law in the country concerned.
	The M-package temperature and the corresponding classes H2, H1, M2, M1, L3, L2, L1.	The temperature of each foodstuff type, affected by its own packaging (dimensions, material, emissivity) and thermal inertia.
	The same standardized loading throughout the test.	A continuous loading variation throughout the day.
The surrounding space is:	The test room climate class and the corresponding stabilised conditions (example: Class 3: 25 °C, 60 % RH).	Some variations of temperature and humidity, notably between day and night.
	A little variation of temperature along the test room height.	A significant stratification of the temperature in the chilled foodstuff zone in the store which is favourable for cabinet running.
	A continuous and horizontal air flow at 0,2 m/s (0; -0,1) which highlights the weak points of the cabinet and so imposes a strong air flow influence.	Some short disruptions made by consumers which creates few disturbances because they are spaced in time and length.
	A defined infrared radiation from the internal lab surfaces.	An undefined infrared radiation from the store surfaces, depending on building insulation, air stratification, lighting type.
The performance evaluation is taken on:	The M-package temperature when the variation is less than 0,5 °C after 24 h in stable conditions.	The foodstuffs temperature in the cabinet; it can depend on the foodstuff temperature at the loading; the most exposed to the infra red radiation, will be the first taken by the consumers.
	And the heat extraction rate and the electrical energy consumption measured according to ISO 23953.	The real needs of the store are the figures to calculate the refrigerating system and the yearly energy consumption, taking into account the seasons (summer/winter), the daily cycle (day/night), the store opening periods.

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Annex D (informative)

Test for absence of odour and taste

D.1 Preparation and testing

D.1.1 Ambient temperature

The ambient temperature shall be between +16 °C and +30 °C.

D.1.2 Cleaning

The cabinet shall be cleaned prior to the test in accordance with the manufacturer's instructions and afterwards with pure water.

D.1.3 Thermostat setting

The cabinet shall be operated for 48 h, with the thermostat and other control devices set in accordance with the manufacturer's instructions that will give the required temperature according to the relevant classification (see 4.2.2).

D.1.4 Samples

The analytical samples and check samples respectively for each cabinet or compartment are:

- 100 ml potable water;
- a slice of fresh unsalted butter of 75 mm × 35 mm × 5 mm.

From each of the above, six samples at least are necessary to serve as analytical samples and six at least to serve as check samples.

The analytical samples shall be placed in Petri dishes and the check samples in glass containers, the latter being hermetically sealed.

Prior to the test, all Petri dishes and containers which are used for the test shall be cleaned with fuming nitric acid and subsequently washed with distilled water until a complete absence of odour is obtained.

The analytical samples of water and butter shall be placed uncovered into the cabinet or compartment. The check samples in the hermetically sealed glass containers shall be placed close to the analytical samples.

D.1.5 Test period

The analytical samples and the check samples shall be left in the operating cabinet with the door(s), if any, closed and at the specified temperature conditions for 48 h. After 48 h, the analytical samples shall be covered.

The analytical samples and check samples shall be removed and warmed to approximately 20 °C.

D.2 Examination of samples

D.2.1 Conditions

Examination shall be made about 2 h after removal of the samples from the cabinet and shall be carried out by at least three examiners familiar with the test method.

Each examiner shall receive

- two analytical samples of water,
- two check samples of water,
- two analytical samples of butter, and
- two check samples of butter.

The identity of the samples shall not be made known to the examiners.

The samples of water shall be examined prior to the samples of butter, unless a separate examination by different examiners takes place.

The examiners shall record their remarks independently of each other, in writing.

D.2.2 Evaluation

The evaluation of the analytical samples shall be carried out with reference to the following scale.

- Mark 0: no foreign odour or foreign taste
- Mark 1: slight foreign odour or foreign taste
- Mark 2: definitely perceptible foreign odour or foreign taste
- Mark 3: distinct foreign odour or foreign taste

When the mean value of the individual results during each evaluation for odour and taste exceed Mark 1, the test shall be repeated. The following provisions shall be made for this second test:

- defrosting of the evaporator;
- cleaning of the cabinet or compartments;
- operation of the empty cabinet for one week;
- repetition of defrosting of the evaporator;
- temperature adjustment for the second test for absence of odour and taste.

Bibliography

- [1] EN 378-1, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 1: Basic requirements, definitions, classification and selection criteria*
- [2] EN 614-1, *Safety of machinery — Ergonomic design principles — Part 1: Terminology and general principles*
- [3] EN 12830, *Temperature recorders for the transport, storage and distribution of chilled, frozen, deep-frozen/quick-frozen food and ice cream — Tests, performance, suitability ratified european text*

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