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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

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

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This document was prepared by Technical Committee ISO/TC 86, *Refrigeration and air-conditioning*, Subcommittee SC 7, *Testing and rating of commercial refrigerated display cabinets*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 44, *Commercial and Professional Refrigerating Appliances and Systems, Performance and Energy Consumption*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This third edition cancels and replaces the second edition (ISO 23953-2:2015), which has been technically revised.

The main changes are as follows:

— revision of:

  — the scope has been revised as this document not applicable to commercial beverage coolers covered by ISO 22044 and ice cream freezers covered by ISO 22043;

  — mass flow with EEV only, to adapt standard to technological improvement;

  — $E_{CPEC,24h}$ also for brine / indirect cooling;

  — testing repeatability;

  — requirements for refrigerant with glide;

— addition of:

  — extrapolation methods for liquid cooled condensing units, depth, height, length and plug-in alternative components;

  — liquid cooled condensing unit (semi plug-in) type;

— S_{TDA} for new types of cabinets;

— standard rating conditions and configurations;

— marking, load limits, multiple loading line for different M-package temperature.

A list of all parts in the ISO 23953 series can be found on the ISO website.

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

Refrigerated display cabinets —

Part 2: Classification, requirements and test conditions

1 Scope

This document specifies requirements for the performance of refrigerated display cabinets used in the sale and display of foodstuffs and construction characteristics impacting performance. 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.

This document is not applicable to refrigerated vending machines, commercial beverage coolers covered by ISO 22044, ice cream freezers covered by ISO 22043. It is also not applicable to cabinets intended for storage or cabinets intended for use, for instance, in catering or non-retail refrigerated applications.

This document does not cover health and safety aspects and ergonomic principles.

This document is not intended to specify storage temperature for foodstuff.

2 Normative references

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

ISO 817:2014, *Refrigerants — Designation and safety classification*

ISO 5149-2:2014, *Refrigerating systems and heat pumps — Safety and environmental requirements — Part 2: Design, construction, testing, marking and documentation*

ISO 23953-1:2023, *Refrigerated display cabinets — Part 1: Vocabulary*

IEC 60335-1:2020, *Household and similar electrical appliances — Safety — Part 1: General requirements*

IEC 60335-2-89:2019, *Household and similar electrical appliances — Safety — Part 2-89: Particular requirements for commercial refrigerating appliances and ice-makers with an incorporated or remote refrigerant unit or motor-compressor*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 23953-1:2023 and the following apply.

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

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

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

3.1.1
running time
t_{run}
time during which compressor is running (or solenoid valve is open) or secondary refrigerant is circulating (or solenoid valve is open), within 24 h

3.1.2
stopping time
t_{stop}
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

3.1.3
defrost time
t_{deft}
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

3.2 Symbols

3.2.1 General

t_{run} running time, expressed in h

t_{stop} stopping time, expressed in h

t_{deft} defrost time, expressed in h

q_m mass flow rate of liquid refrigerant or secondary refrigerant in kg/s

Δt time between two consecutive measuring samples, in h

N_{max} number of measuring samples in 24 h

n_{deft} number of defrosts during 24 h

Φ_{24} heat extraction rate during a whole day, in kW

$\Phi_{24\text{-deft}}$ heat extraction rate during a whole day excepting defrost time, in kW

$E_{ACE,24h}$ anti-condensate energy consumption, in kWh

E_{add} additional refrigeration energy consumption, in kWh

E_{CEC} compressor energy consumption, in kWh

$E_{CPEC,24h}$ pumping electrical energy consumption, in kWh

E_{CSEC} cooling system energy consumption, in kWh

$E_{DEC,24h}$ direct daily electrical energy consumption, in kWh

E_{DFEC} defrost energy consumption, in kWh

E_{FEC} fan energy consumption, in kWh

$E_{HEC,24h}$ heat extracted condenser, in kWh

$E_{HECR,24h}$ revised heat removal energy consumption, in kWh

$E_{HLE,24h}$ heat load extracted daily, in kWh

E_{HREC} heat removal energy consumption, in kWh

E_{HRECA} additional heat removal energy consumption, in kWh

E_{LEC} lighting energy consumption, in kWh

E_{PEC} condensate evaporator pan energy consumption, in kWh

$E_{REC,24h}$ refrigeration electrical energy consumption, in kWh

$E_{REC\text{-}RC,24h}$ refrigeration electrical energy consumption compression-type, in kWh

$E_{REC\text{-}RI,24h}$ refrigeration electrical energy consumption indirect, in kWh

$E_{RECA,24h}$ additional refrigeration daily electrical energy consumption, in kWh

$E_{RECR,24h}$ revised refrigeration energy consumption, in kWh

E_{SEC} specific daily electrical energy consumption, in kWh/m²

E_{TEC} total energy consumption, in kWh

E_{TECR} total revised daily electrical energy consumption, in kWh

$E_{TECR,24h}$ total revised daily electrical energy consumption, in kWh

t_{rr} relative or percentage running time:

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

where

$$t_{run} + t_{stop} + t_{deft} = 24$$

Φ_n instant heat extraction rate in kW

3.2.2 Compression-type refrigeration systems

h_8, h_4 specific enthalpy in kJ/kg, where state at point 8 corresponds to refrigerant outlet, and state at point 4 to refrigerant inlet, of cabinet

θ_7 refrigerant temperature at evaporator outlet, in °C

θ_8 refrigerant temperature at cabinet outlet, in °C

θ_4 refrigerant temperature at cabinet inlet, in °C

θ_5 refrigerant temperature at evaporator inlet, in °C

θ_{mrun} evaporating temperature, calculated as the average of θ_{dew} and θ_{bub} obtained from pressure p8 and averaged over the t_{run} period, in °C

θ_{cond} condensing temperature, calculated as the average of θ_{bub} and θ_{dew} obtained from pressure p4 and averaged over the t_{run} period, in °C

θ_{min} evaporating temperature, calculated as the average of θ_{dew} and θ_{bub} obtained from pressure p8 by referring to table of saturation temperature in use and averaged over the last 10 % of all t_{run} periods in °C

T_{mrun} $= \theta_{mrun} + 273{,}15$ in Kelvin

3.2.3 Indirect refrigeration-type systems

θ_i secondary refrigerant temperature at cabinet inlet, in °C

θ_o secondary refrigerant temperature at cabinet outlet, in °C

θ secondary refrigerant median temperature, in °C $(\theta_i + \theta_o)/2$

θ_{mrun} arithmetic average of the secondary refrigerant median temperature (θ) during t_{run}, in °C

q_L instant value of the secondary refrigerant mass flow during t_{run}, in kg/s

c_i specific heat of secondary refrigerant, in kJ/(kg · K), at cabinet inlet

c_o specific heat of the secondary refrigerant, in kJ/(kg · K), at cabinet outlet

$p_{irun} - p_{orun}$ pressure drop between inlet and outlet of cabinet during t_{run}, in kPa

v specific volume of secondary refrigerant, in m^3/kg
(simplification: v = constant = 0,001 m^3/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. 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 fitments which are provided with stops to prevent accidental removal shall be self-supporting when fully loaded and withdrawn to the limit of the stops;

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 sufficient capacity at the rated climate class conditions.

NOTE Drains, drip trays or evaporation receptacles are to 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.

Hinged lids and doors shall be opened by different angles of at least 60°.

Transparent doors and lids shall be condensate-free at the climate class specified by the manufacturer.

NOTE Intermittent misting only is allowed, see 5.3.5.2.

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.

4.1.2 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 are 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 ISO 5149-2:2014.

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.

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 ISO 5149-2:2014.

4.1.5 Electrical components

Electrical components shall be in accordance with IEC 60335-2-89:2019 and IEC 60335-1:2020.

Cabinets should incorporate a means of controlling all or part of the lighting using a manual switch, sensor, timeclock or provision for an external control with a similar automatic device.

4.1.6 Temperature display

4.1.6.1 General

The cabinets shall incorporate a temperature display instrument and can additionally have a means of temperature monitoring, 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.

4.1.6.2 Temperature-measuring instrument

Temperature-measuring instruments shall be used, i.e. fulfil the following requirements:

— the unit symbol (°C or °F) 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).

4.1.6.3 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 can 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.

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

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 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.

4.1.6.4 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 C.

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 5.3.4.

NOTE Annex B compares laboratory and store condition.

Table 1 — M-package temperature classes

Class	Highest temperature, θ_{ah}, of warmest M-package colder than or equal to [a,b]	Lowest temperature, θ_b, of coldest M-package warmer than or equal to [b]	Highest minimum temperature, θ_{al}, of all M-package colder than or equal to [a]
	°C		
L1	−15	—	−18
L2	−12	—	−18
L3	−12	—	−15
M0	+4	−1	—
M*	6	−1	—
M1	+5	−1	—
M2	+7	−1	—
H1	+10	+1	—
H2	+10	−1	—
S	Special classification		

[a] See Figure 31a).

[b] See Figure 31b).

For class M, the highest temperature of warmest package θ_{ah} colder than or equal to 6,1 °C but the average of the warmest M package colder than or equal to 5 °C. The measured temperatures are rounded to zero decimal places for temperature classification (see 5.3.4.6).

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.

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

Condensation shall not form water droplets resulting in running water on any external surfaces or pool on surfaces adjacent to the cabinet (e.g. floor) under the condition of the design temperature performance and climate class.

Internal surfaces shall remain free of running water to an intensity that may cause wetting of the products displayed in the cabinet under the condition of the design temperature performance and climate class.

The amount of water vapour condensation shall be verified according to the conditions and test methods specified in 5.3.5.

4.2.5 Energy consumption

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

The direct daily electrical energy consumption ($E_{DEC,24h}$) and, when the condensing unit is remote from the cabinet, the refrigeration daily electrical energy consumption ($E_{REC,24h}$) and total daily energy consumption (E_{TEC}) shall be measured and calculated according to the conditions and the test methods specified in 5.3.6 and 5.3.7.

4.2.6 Specific energy consumption

The cabinet specific daily electrical energy consumptions E_{SEC} as ratio between E_{TEC} and S_{TDA} shall be stated by the manufacturer. This value represents the best index for performance evaluation of a commercial refrigerated display cabinet.

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 document using the appropriate test method.

Table 2 — Test summary

<table>
<tr><th>Tests and inspections</th><th>Requirement subclause in this document</th><th>Test method</th><th></th></tr>
<tr><td>Seal test</td><td>4.1</td><td>5.2.2</td><td rowspan="2">Outside test room (see 5.2)</td></tr>
<tr><td>Absence of odour and taste (not compulsory)</td><td>—</td><td>Annex C</td></tr>
<tr><td>Temperature</td><td>4.2.2</td><td>5.3.4</td><td rowspan="4">Inside test room (see 5.3)</td></tr>
<tr><td>Defrosting</td><td>4.2.3</td><td>5.3.4</td></tr>
<tr><td>Water vapour condensation</td><td>4.2.4</td><td>5.3.5</td></tr>
<tr><td>Energy consumption</td><td>4.2.5</td><td>5.3.6 and 5.3.7</td></tr>
</table>

5.2 Tests outside test room

5.2.1 General

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

5.2.2 Seal test for doors and lids on low temperature applications

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 The most unfavourable points can be found by inspecting the contact of the seal with the cabinet closed and lit from the inside.

5.2.3 Linear dimensions, areas

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.

The total display area (S_{TDA}) shall be calculated according to Annex A.

5.3 Tests inside test room

5.3.1 General

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

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

These measurements should be made simultaneously.

5.3.2 General conditions

5.3.2.1 General

In the following, general testing conditions which are common for all tests specified in 5.3.4 to 5.3.7 carried out inside the test room are defined. These conditions concern the test room, the test and M-packages, and the measuring instruments.

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

The test room shall be a parallelepiped space 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 5.3.3.1).

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 (λ = 0,03 W/m °C) should be used for the building of a new test room.

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

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

The walls, ceilings and any partitions of rooms intended for the testing of refrigerated display cabinets shall be painted in light grey (for example, NCS 2706-G90Y or RAL 7032) so that the emissivity is between 0,9 and 1 at 25 °C.

5.3.2.3 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 m^2 surface area facing the discharge technical side wall exist along the walls.

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

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

The test room shall be capable of maintaining values of humidity within ±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.

5.3.2.4 Test room climate definition

5.3.2.4.1 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 5.3.2.4.2). 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 °C	Relative humidity %	Dew point °C	Water vapour mass in dry air g/kg
0	20	50	9,3	7,3
1	16	80	12,6	9,1
8	24	55	14,4	10,2
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

NOTE The water vapour mass in dry air is one of the main points influencing the performance and the energy consumption of the cabinets. Therefore, the order of the climate class in the table is based on the water vapour mass column. See also Annex B to compare lab and store conditions.

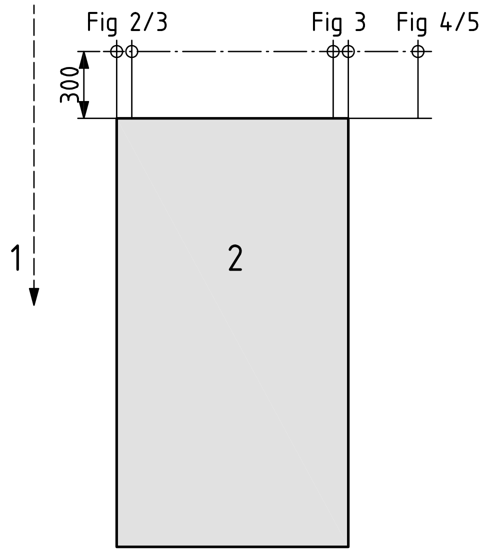
5.3.2.4.2 Climate measuring point

The point for measurement of ambient temperature and relative humidity shall be placed 300 mm upstream towards the test room air supply wall in accordance with plan view in Figure 1 and section views in Figures 2, 3, 4 and 5.

In the case of typical island cabinets, and island with air discharge in the middle, temperatures shall be taken at both sides (see Figure 2).

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 (see 5.3.3.1, Figures 8 and 9).

Dimensions in millimetres



Key

1 room air flow

2 cabinet

Figure 1 — Plan of climate measuring point for Figures 2, 3, 4 and 5

Dimensions in millimetres

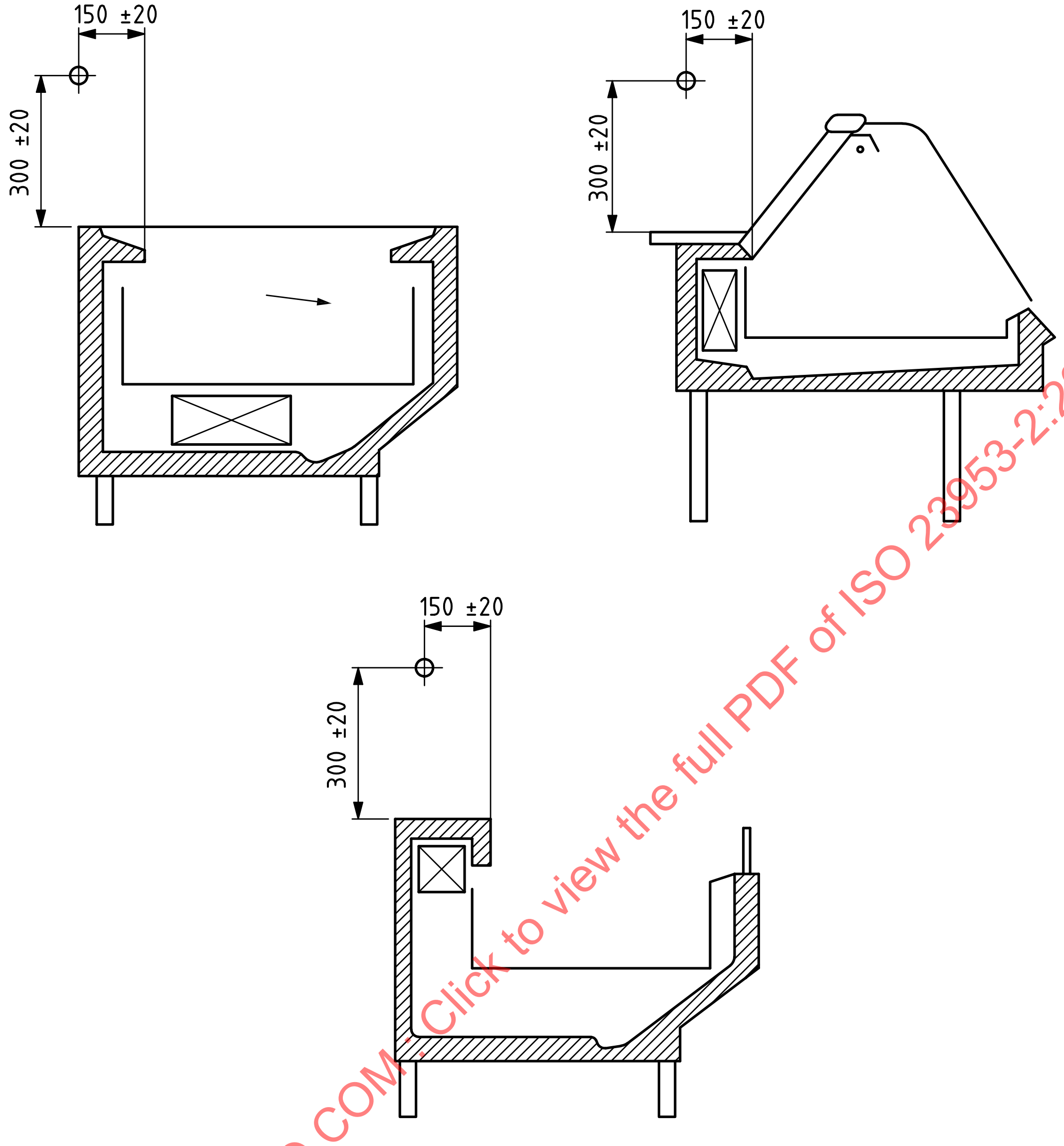
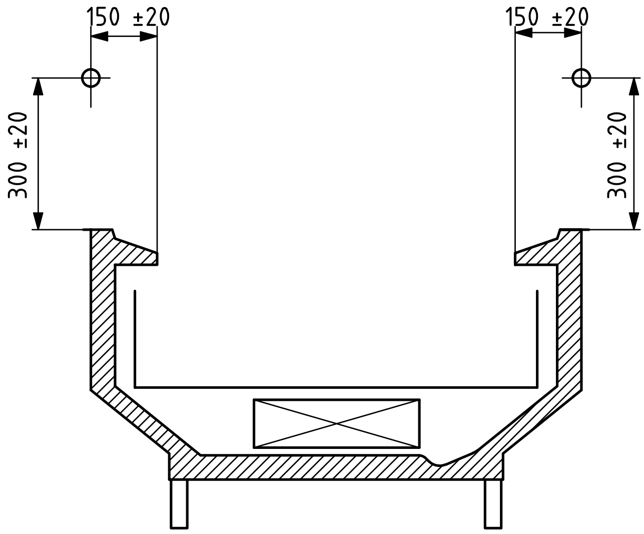
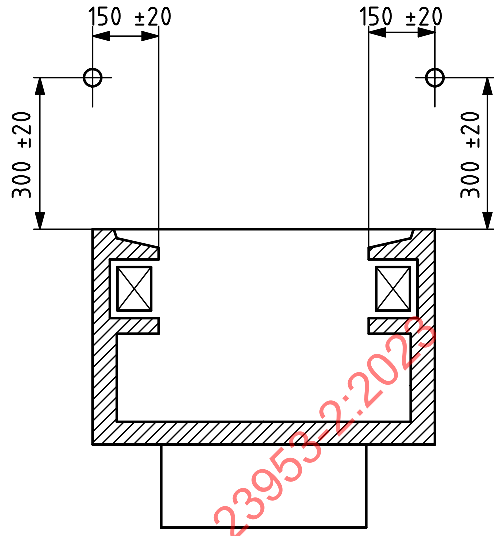


Figure 2 — Climate measuring point for two typical examples of horizontal open, wall site cabinets, and one example of serve-over counter cabinet

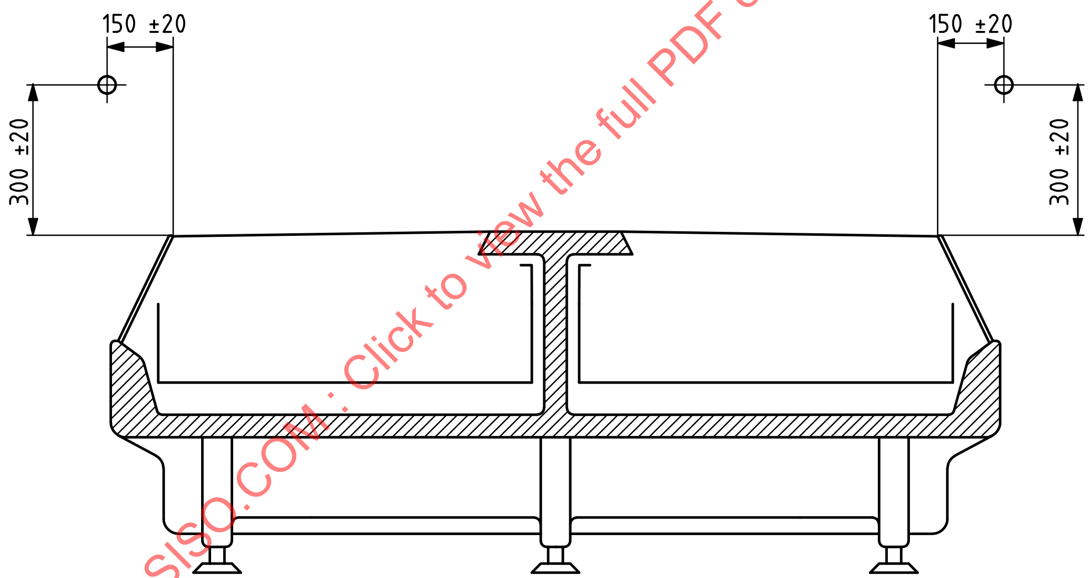
Dimensions in millimetres



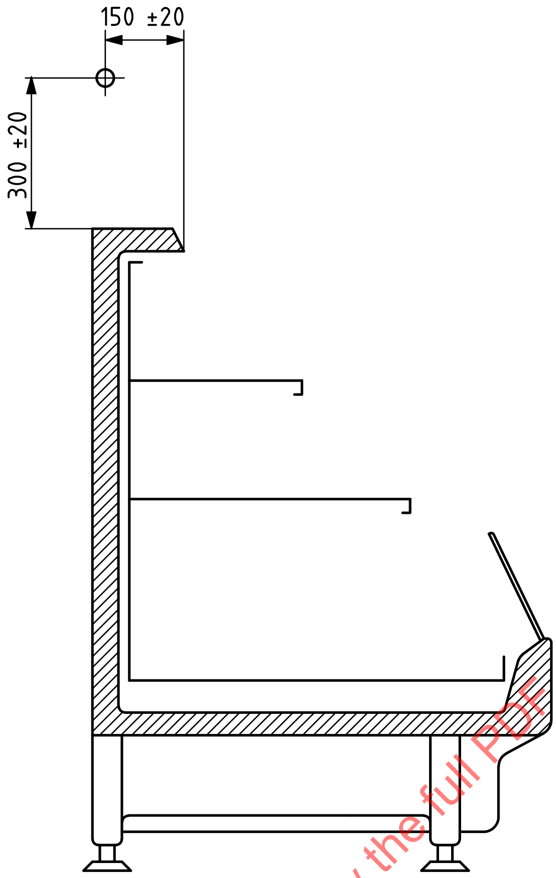
a) Example of horizontal, open, island site cabinet



b) Example of horizontal, open, island site cabinet



c) Island cabinet with air discharge in the middle



d) Semi-vertical cabinet

Figure 3 — Climate measuring point for two typical examples of horizontal, open, island site cabinets [a), b)] for island with air discharge in the middle [c)] and for semi-vertical cabinet [d)]

Dimensions in millimetres

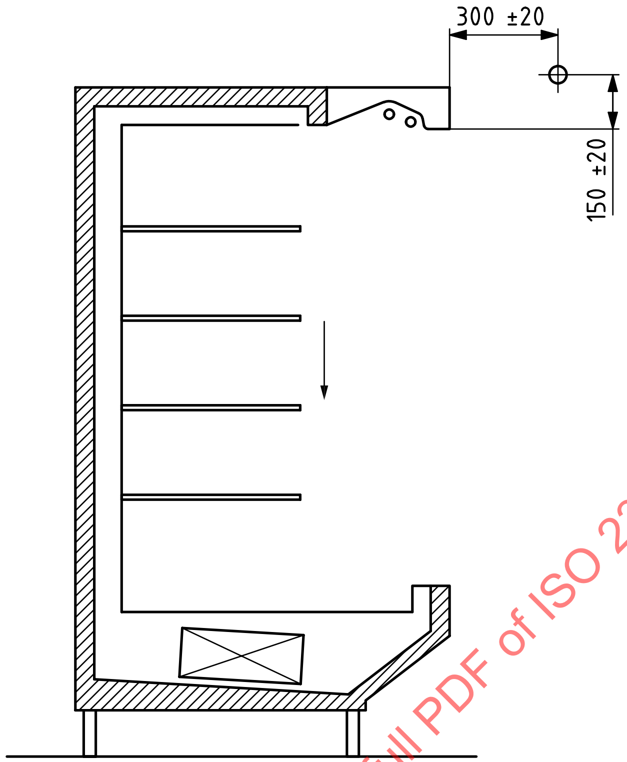


Figure 4 — Climate measuring points for one typical example of vertical multi-deck cabinet

Dimensions in millimetres

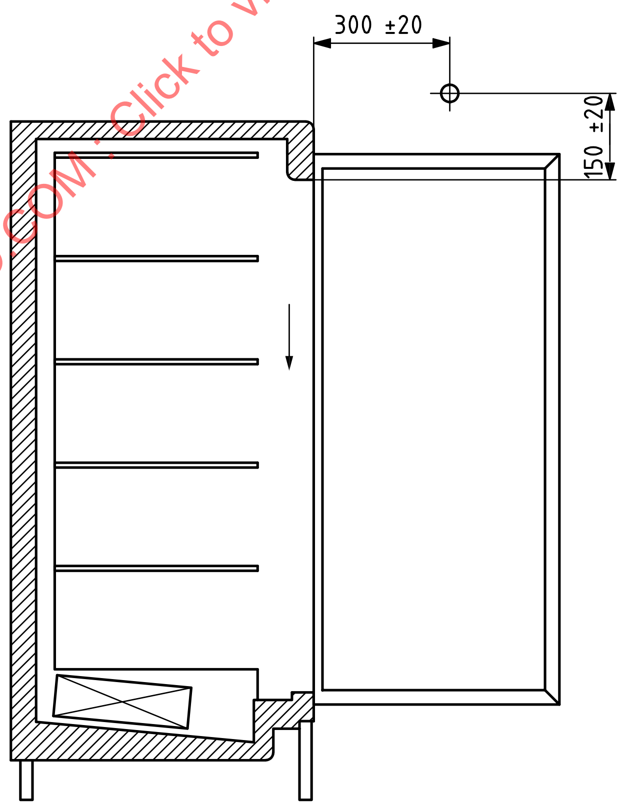


Figure 5 — Climate measuring point for one typical example of vertical glass door cabinet

5.3.2.5 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

Due to the frequency of use and to the loading pressure, the package could change in dimensions and weight. Test packages shall be checked at least 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

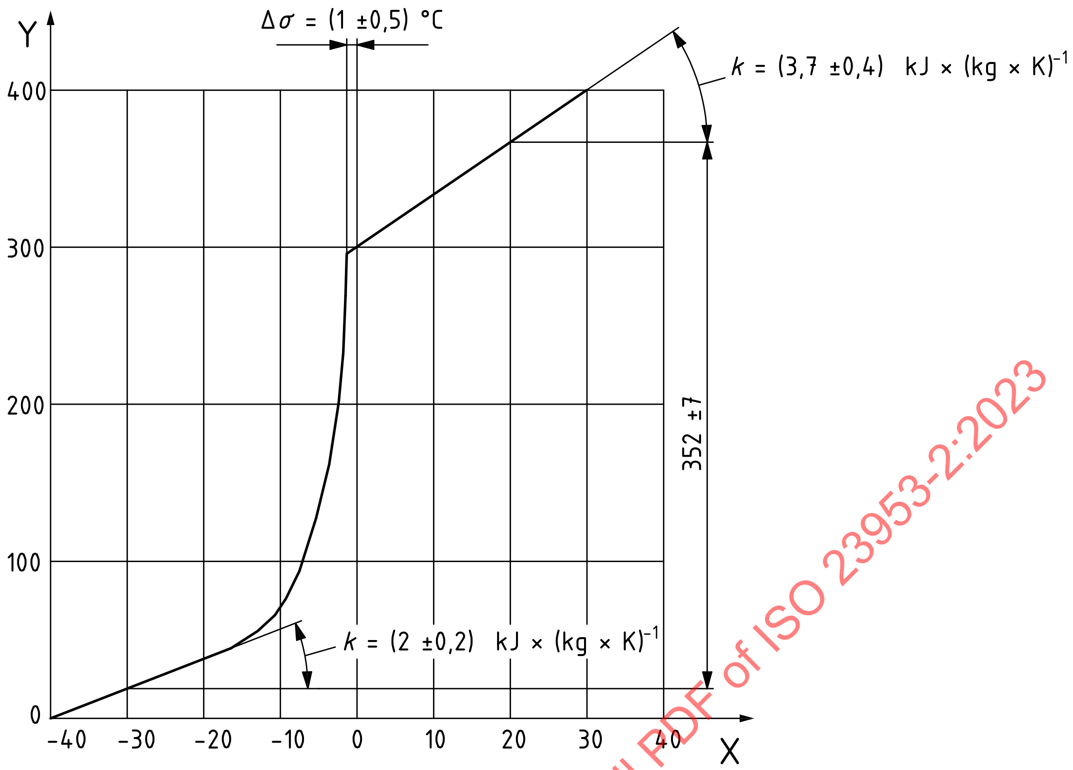
— 0,8 g of para-chlorometa-cresol.

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 ± 0,5) °C (see Figure 6, Tables 5 and 6).

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

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

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



Key

X temperature, °C

Y specific enthalpy, kJ/kg

Figure 6 — 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

Table 5 *(continued)*

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

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

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

5.3.2.6 M-packages and life-time

Some of the 500 g packages (50 mm × 100 mm × 100 mm) specified in 5.3.2.5 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 7).

Due to frequency of use and loading pressure the package could change in dimensions and weight. All M-packages shall be checked at least annually for conformity with the life time tolerances specified in 5.3.2.5. The checking results shall be recorded for each lot of M-packages. When an M-package is found to exceed one of the tolerances, it shall be replaced.

Dimensions in millimetres

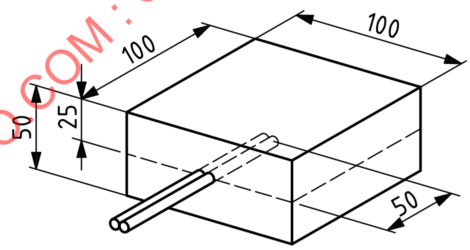


Figure 7 — M-Package

5.3.2.7 Alternative for filling test packages

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

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

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

The contents shall be water containing 0,08 % of para-chlorometa-cresol and 0,5 % of sodium chloride, soaked into a porous material such as a natural, plastics or cellulose sponge.

5.3.2.8 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 ±0,8 °C. Climate temperatures shall be measured by sensors, inserted in the centre of tinned solid copper or copper-zinc alloy cylinders having a mass of 25 g and of minimum external area (diameter = height = approximately 12,5 mm).

Specially for the test of a cabinet intended for connection to an indirect type refrigerating system, secondary refrigerant temperature difference measurements shall be made to an accuracy of ±0,1 °C (see 5.3.7.2.2).

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

— Pressures shall be measured to an accuracy of ±1 % during the t_{run} period of operation of the cabinet.

— 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 5.3.6).

— 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 less than or equal to 20 s (see 5.3.7.2).

In the case of electronic expansion valves (EEV), measurements shall be sampled at a rate to avoid undersampling due to the periodic openings of the valve.

NOTE According to the Nyquist-Shannon sampling theorem, undersampling means sampling a periodic signal with a frequency below 2 times the frequency of the signal itself.

— Air velocity shall be measured using a laboratory-type instrument with an accuracy of 10 % or ±0,03 m/s whichever is the greater and with a minimum sensitivity of 0,03 m/s in the range of 0 m/s 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 % during the t_{run} period of operation of the cabinet (see 5.3.7).

5.3.3 Preparation of test cabinet and general test procedures

5.3.3.1 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 8).

$X \geq 1,5$ 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* ≥ 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 23953-1:2023, Annex A);

— Y ≥ 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 Annex A);

— *A* ≥ 0,8 m

A = *Y* should be used when *A* ≥ 1,5 m;

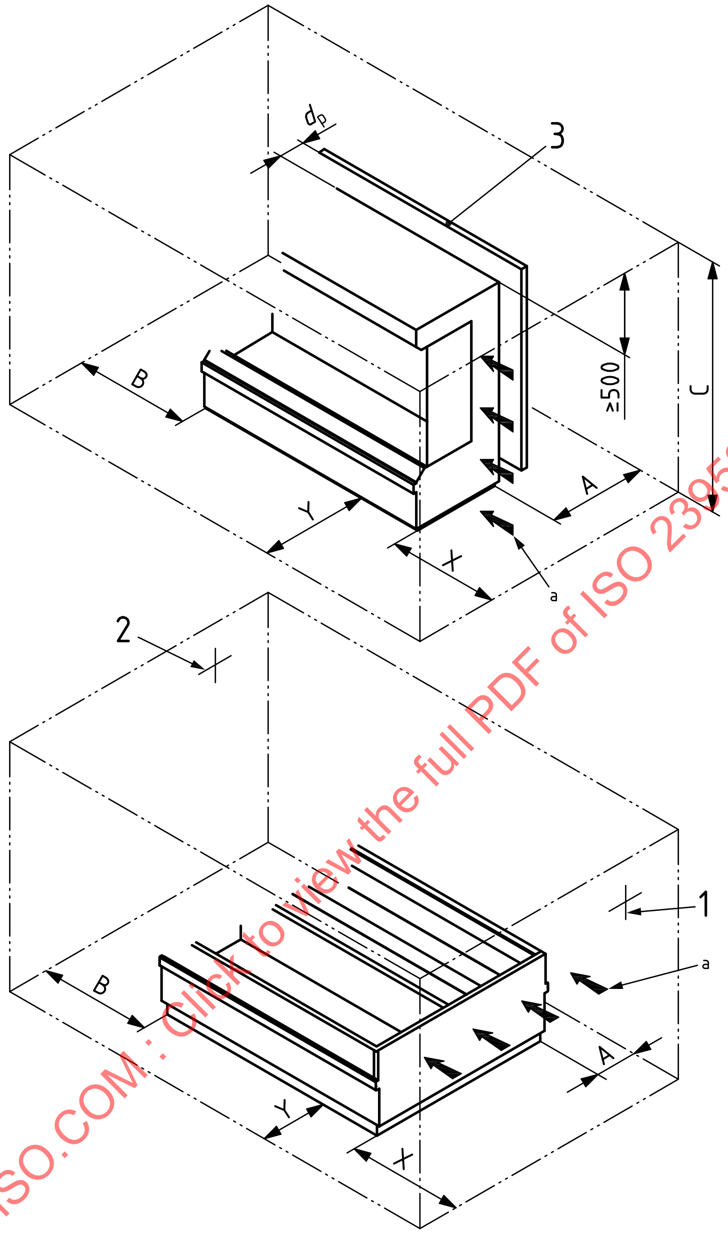
— C ≥ height of cabinet +0,5 m (for vertical cabinets).

The cabinet shall be located within the test room perpendicularly to the two technical side walls in such a way that the distances A (and respectively Y) measured at the two ends of the cabinet is equal with a tolerance of ±4 mm for each meter of length of the cabinet.

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 8).

The distance, d_p, between the back of the cabinet and the vertical panel shall be specified by the manufacturer (see Figure 8). Where this is not specified the cabinet shall be tested with the partition placed against the rear of the cabinet. i.e. distance d_p = 0.

Dimensions in millimetres



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 from right to the left or viceversa).

Figure 8 — Cabinet location within test room

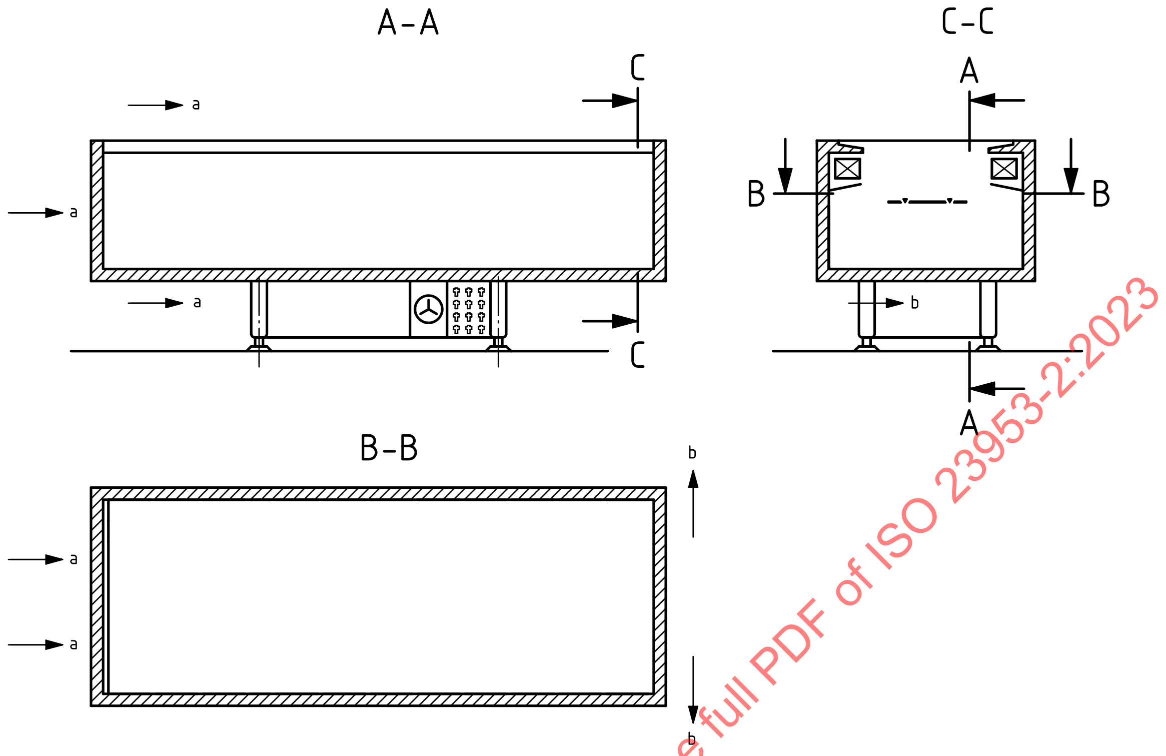
For horizontal plug-in cabinets a back duct is not required.

NOTE In general the power of horizontal cabinets is much lower than that of vertical cases.

The air movement of the test room shall be parallel to the longitudinal axis according to 5.3.3.2.

The direction of the warm condenser airflow should be the same as the test room air flow direction and not opposed to it.

If this is not possible because of the cabinet's design the condenser airflow should be across the test room airflow direction (see Figure 9).



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

b Air flow direction of condensing unit.

Figure 9 — Condensing air with test room air flow, or across, but not opposed the test room air flow

5.3.3.2 Air movement

Air movement shall be provided. The air movement shall be, as far as practicable, parallel to the plane of the cabinet display opening and to the longitudinal axis from right to the left or viceversa. The air flow direction shall not change during the tests. The length of the cabinet is defined as the longest horizontal dimension of the display opening. With the refrigerated display cabinet switched off, the mean horizontal air velocity V_1, V_2 and V_3 shall be measured at A1, A2 and A3 along line A–A in Figure 10 over 1 min with a maximal interval of 5 s.

The average velocity V_{av} is calculated according to Formula (1)

$$V_{av} = (V_1 + V_2 + V_3)/3 \tag{1}$$

V_1, V_2 and V_3 are allowed to be 0,15 $^{+0,05}_{-0,05}$ m/s, provided that V_{av} is 0,15 $^{+0,03}_{-0,03}$ m/s.

The verification of the test room air movement shall be carried out under the intended ambient class.

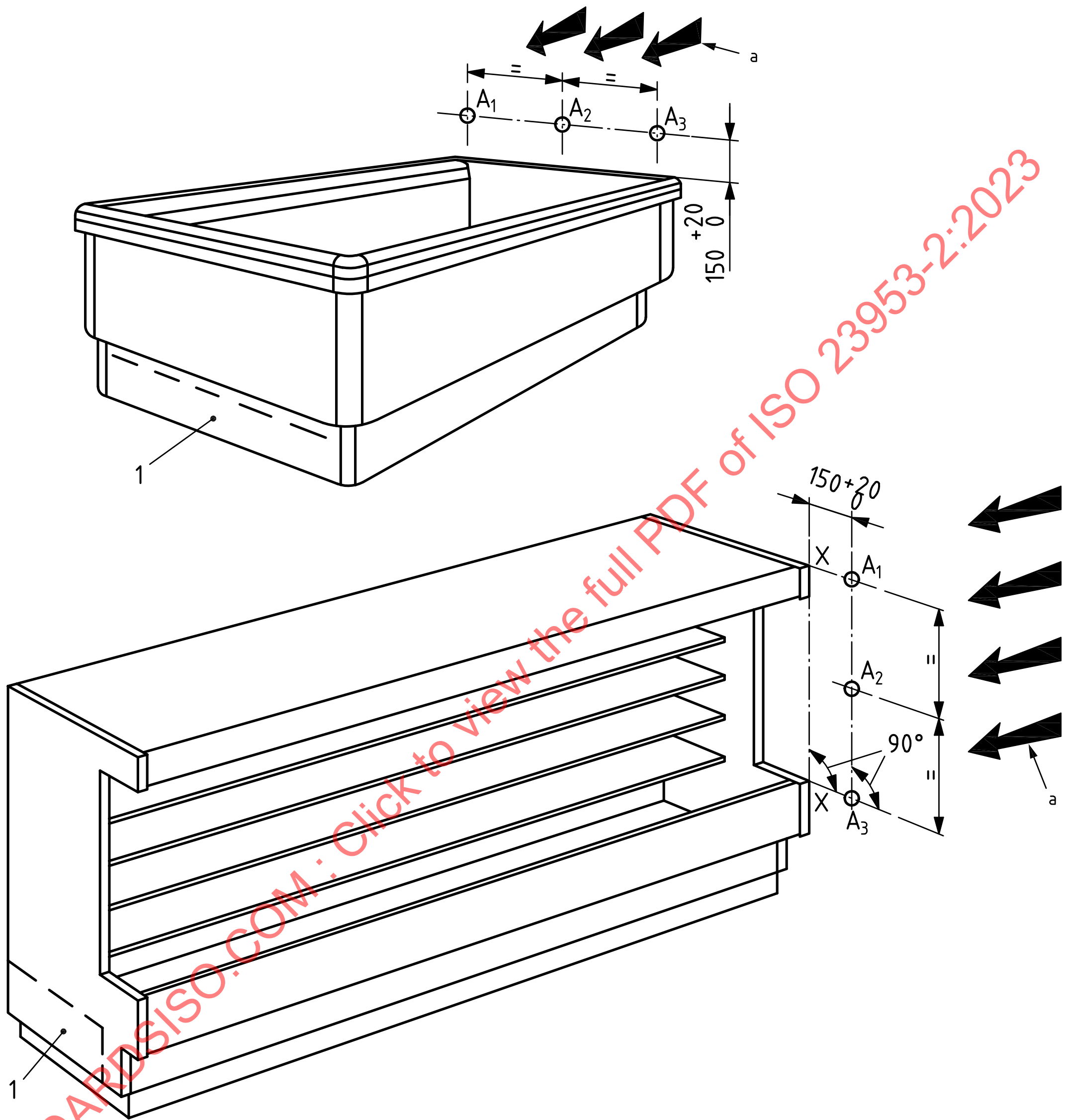
Changes of the test room air velocity after the verification and during the stabilisation and test period are not allowed.

For closed refrigerated cabinets with lids or doors hinged in a way that the rotation axis is perpendicular to the longitudinal axis of the cabinet the direction of air flow shall be such that the air movement is parallel to the plane of the cabinet display opening and the air enters the cabinet when the door(s) or lid(s) is (are) open.

The majority of the doors or lids shall open in order to allow the air entry into the cabinet; if doors or lids can be indifferently hinged left and right, all doors or lids shall open in the same direction.

Test room air movement shall be checked during the test in order to be sure 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 at point A1, A2 and A3

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 from right to the left or viceversa).

Figure 10 — Air movement

5.3.3.3 Loading the cabinet

5.3.3.3.1 General

The cabinet shall be loaded with test packages and M-packages (see 5.3.2.5 and 5.3.2.6) according to 5.3.3.3.2, as illustrated in Figures 11 to 26. These packages shall be pre-chilled/frozen in order not to overload the thermal capacity of the cabinet, to a temperature approximately equal to that expected during the test according to manufacturer's instructions.

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.

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 width 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.

The test packages shall be placed so that they are in contact with the back panel unless physical load limiting stops are provided as part of the cabinet. Where cabinets are provided with load limiting stops, the test packages shall be in contact with the load limiting stops.

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 25), 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.

For roll-in cabinets, if not otherwise stated in the manufacturer’s manual or marked inside the cabinet, the packages and the wood shall be loaded on standard Euro pallets (1 200 × 800 × 144) mm or if not applicable on a similar tray of the same height. The surface of the pallet should be covered by a sheet of plastic or carton so that the packages can be loaded properly.

If the cabinet is designed for the use of special storage trolleys, these trolleys shall be used for testing. In this case the M-packages shall be positioned as specified in the above Figure 25 but inside the trolleys.

NOTE Sensitive foodstuff loading type is possible only for top part (shelves) of this kind of cabinets.

5.3.3.3.2 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 $^{0}_{-25}$ mm (see Figure 11 and Figures 13 to 18).

b) For open chilled 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 $^{0}_{-25}$ mm (see Figures 19 to 23 and Figure 25).

c) For all 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 24).

d) For closed vertical cabinets, the free height is defined by the load limit or the distance between the shelves. Cabinets shall be tested, loaded to either (i) half the free height, (ii) the free height or both (i) and (ii) as follows:

   i) the loading height shall be equal to half of the maximum free height above the refrigerated shelves, with a tolerance of $^{+25}_{0}$ mm (see Figure 26).

   ii) the loading height shall be equal to the free height between the shelves minus 25 mm with a tolerance of $^{0}_{-25}$ mm.

Whether the cabinet was tested to (i) or (ii) or both (i) and (ii) shall be recorded in Tables 10, 11, 13 and 14.

NOTE The meaning of “intended for sensitive foodstuffs not suitable for multiple layer stacking” is that the foodstuffs are displayed on tilted shelves, where it is not possible to make a load level over 100 mm. This type of loading can also be used for horizontal shelves. It is intended that manufacturers indicate the load limit in the technical documentation and also specify the type of loading used for testing the cabinet. In this case also S_{TDA} is calculated consequently referring to the reduced load level (see Figure A.3).

5.3.3.3.3 M-package locations

5.3.3.3.3.1 General

The M-packages shall be placed at the position shown on the cabinet drawings (see Figures 11 to 26).

5.3.3.3.3.2 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.

5.3.3.3.3.3 Cross-section

For all shelf depths, M-packages shall be located into two longitudinal sections, such that the M-package axis is situated at 50 mm from the back panel, or any load limiting stops provided as part of the cabinet and 50 mm from the front limit of loading (see Figures 19 to 26).

For all refrigerated base decks, M-packages shall be located into two longitudinal sections, such that the M-package axis is situated at 50 mm from the back panel and 50 mm from the front limit of loading (see Figures 11 to 26).

Additionally, for refrigerated base deck depths of more than 550 mm, a third longitudinal section shall be placed midway across the base deck depth with a tolerance of

— $d/2\ ^{+100}_{0}$ mm from the air-discharge side for cabinets with forced-air cooling [see Figures 11 to 13, Figure 15 a) and b) and Figures 19 to 26], 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

— $d/2\ ^{+100}_{0}$ 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 Figure 25).

For cabinets with superimposed refrigerated shelves, M-packages shall be located in the following places (see Figures 19 to 26):

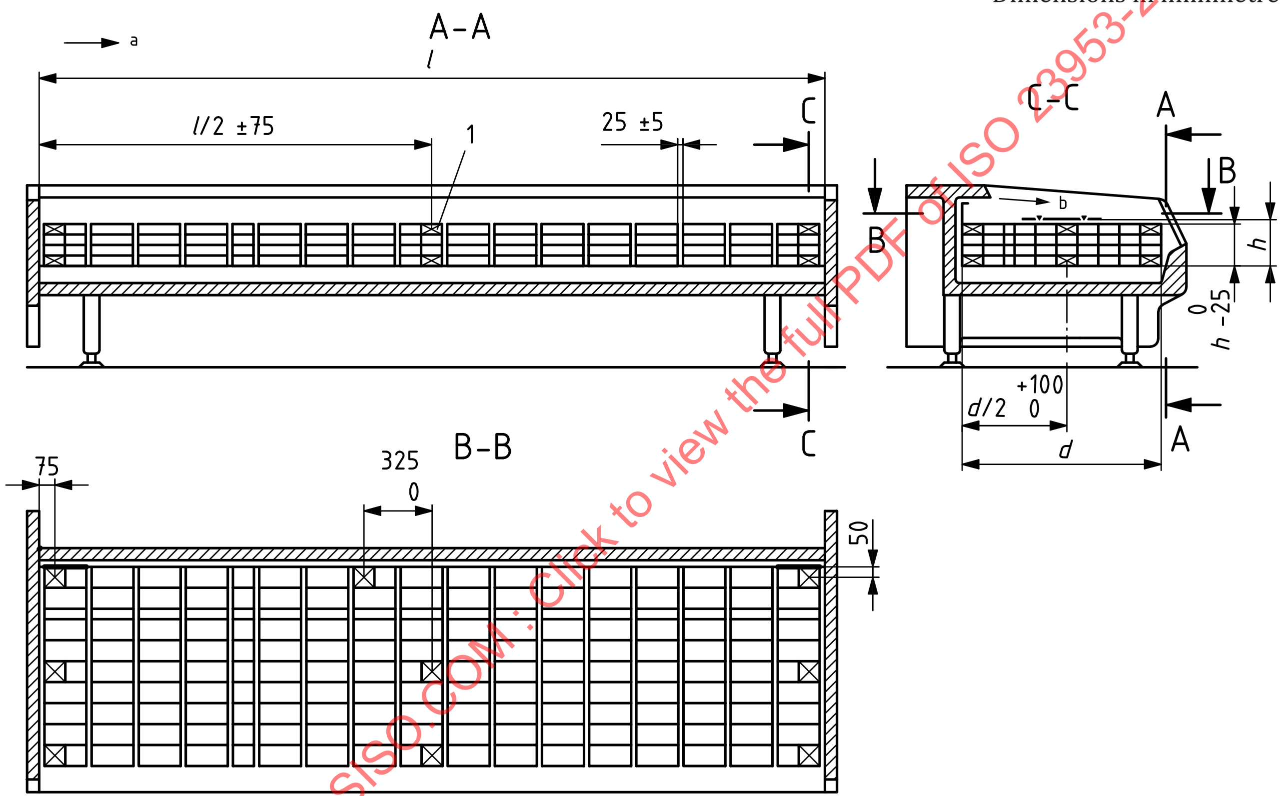
— on the chest;

— on the shelf above the chest;

— on the top shelf;

— plus every alternate shelf starting from the top shelf.

Dimensions in millimetres



Key

1 M-package

d depth of base deck

h height at load limit

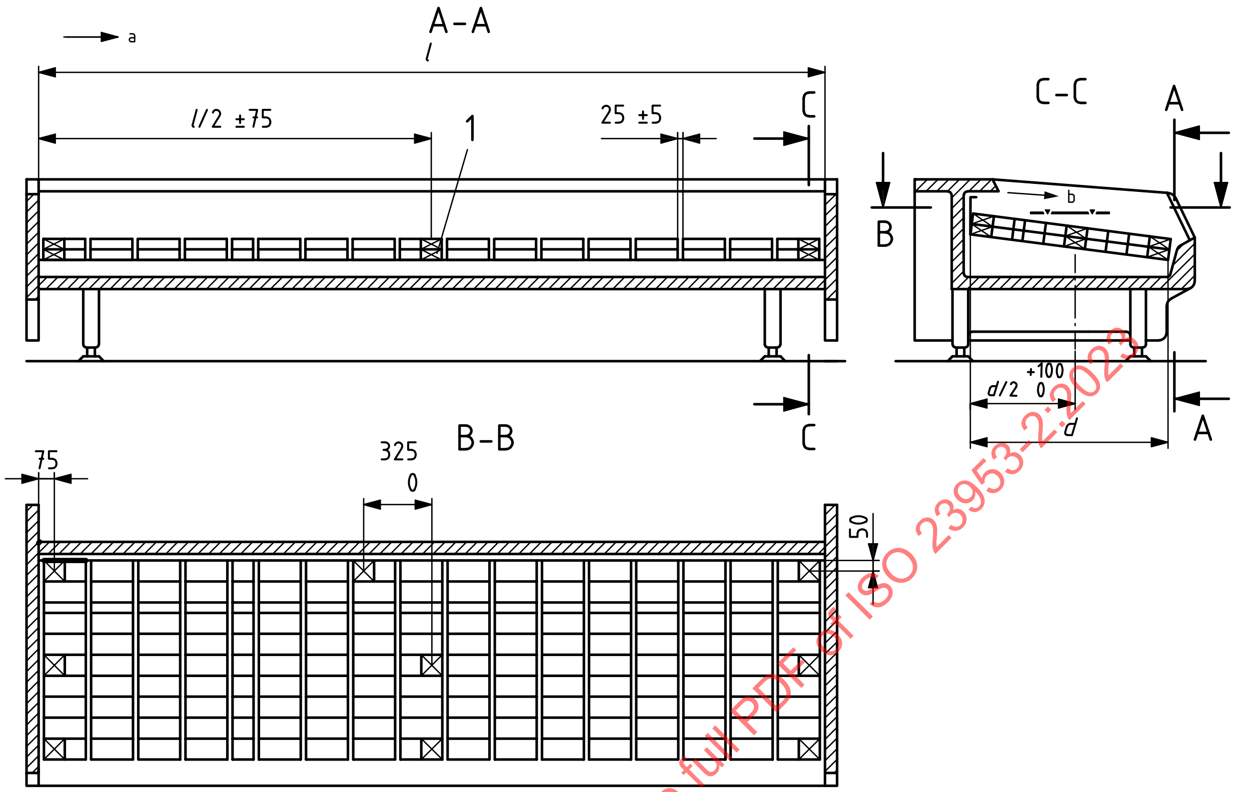
l length of the cabinet

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 and closed)

Dimensions in millimetres



Key

1 M-package

d depth of base deck

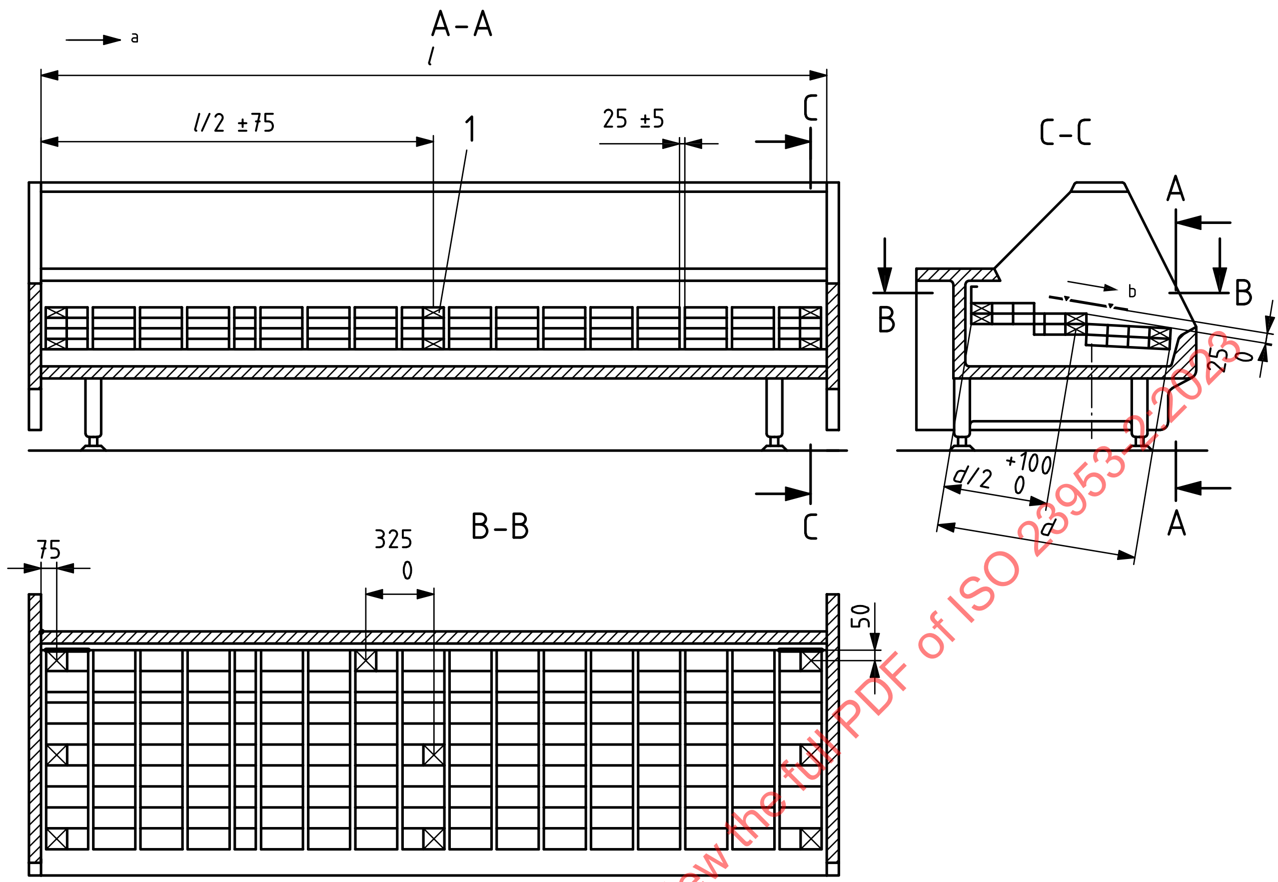
l length of the cabinet

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

b Direction of forced air flow.

Figure 12 — Self-service counter provided with forced air cooling for sensitive foodstuffs (horizontal, open and closed)

Dimensions in millimetres



Key

1 M-package

d depth of base deck

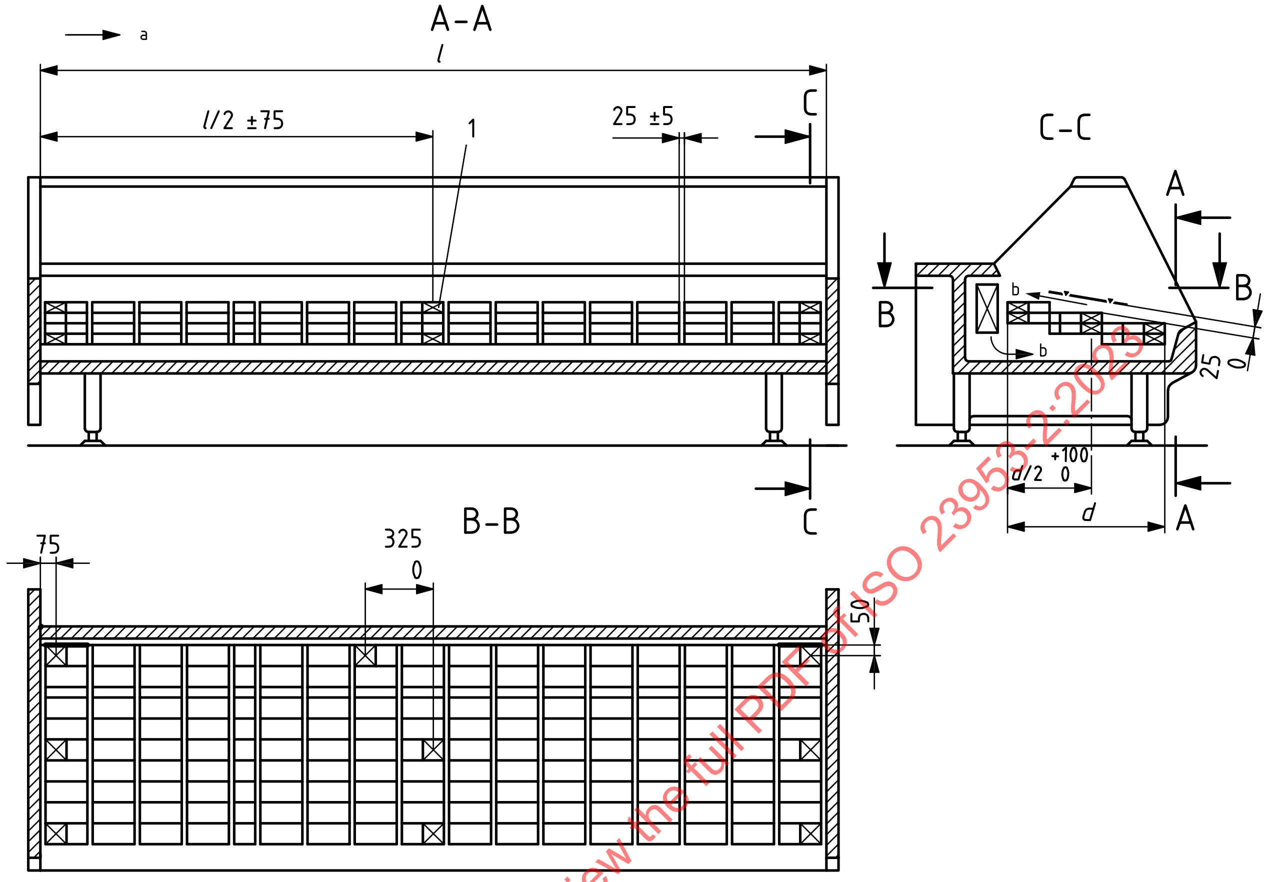
l length of the cabinet

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 open and closed)

Dimensions in millimetres



Key

1 M-package

d depth of base deck

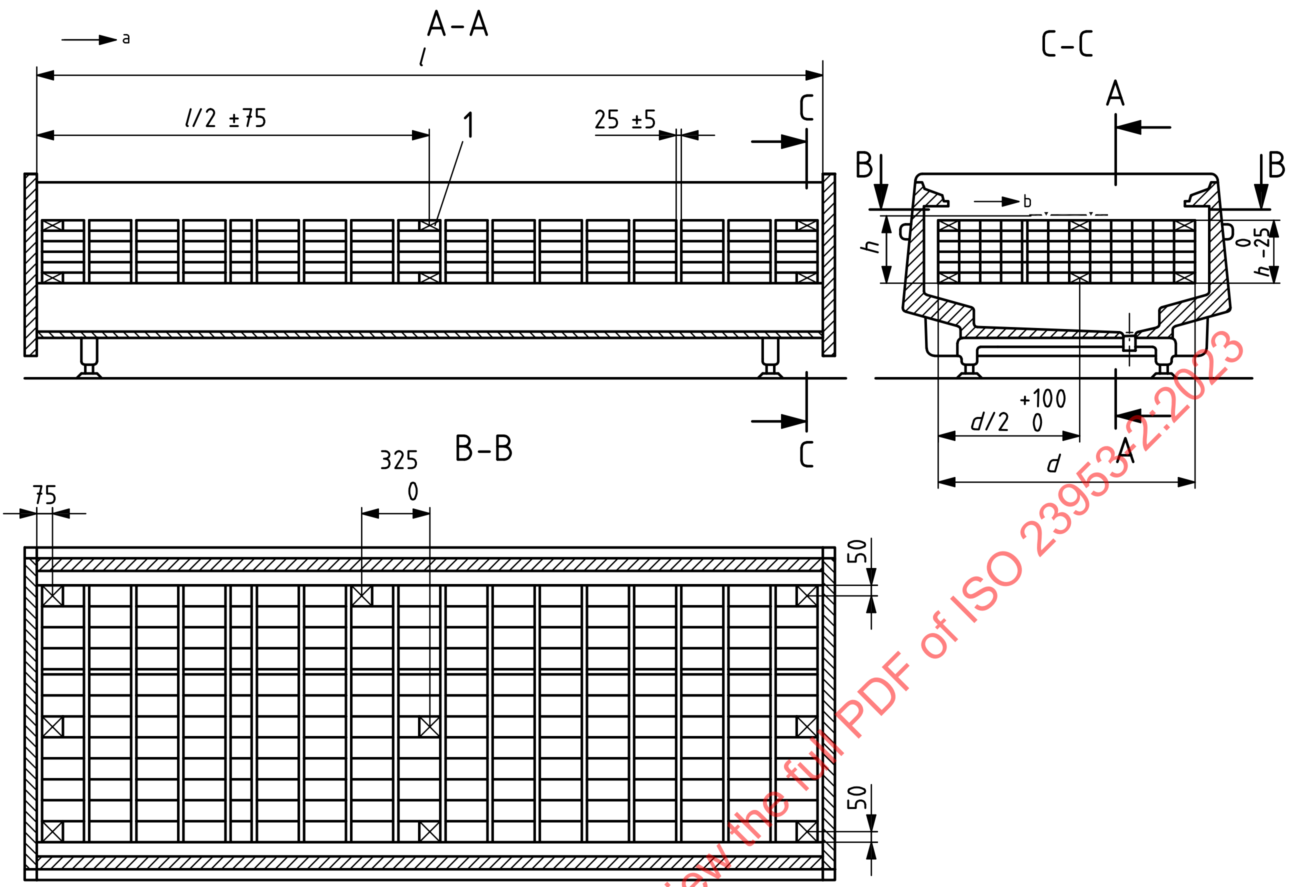
l length of the cabinet

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

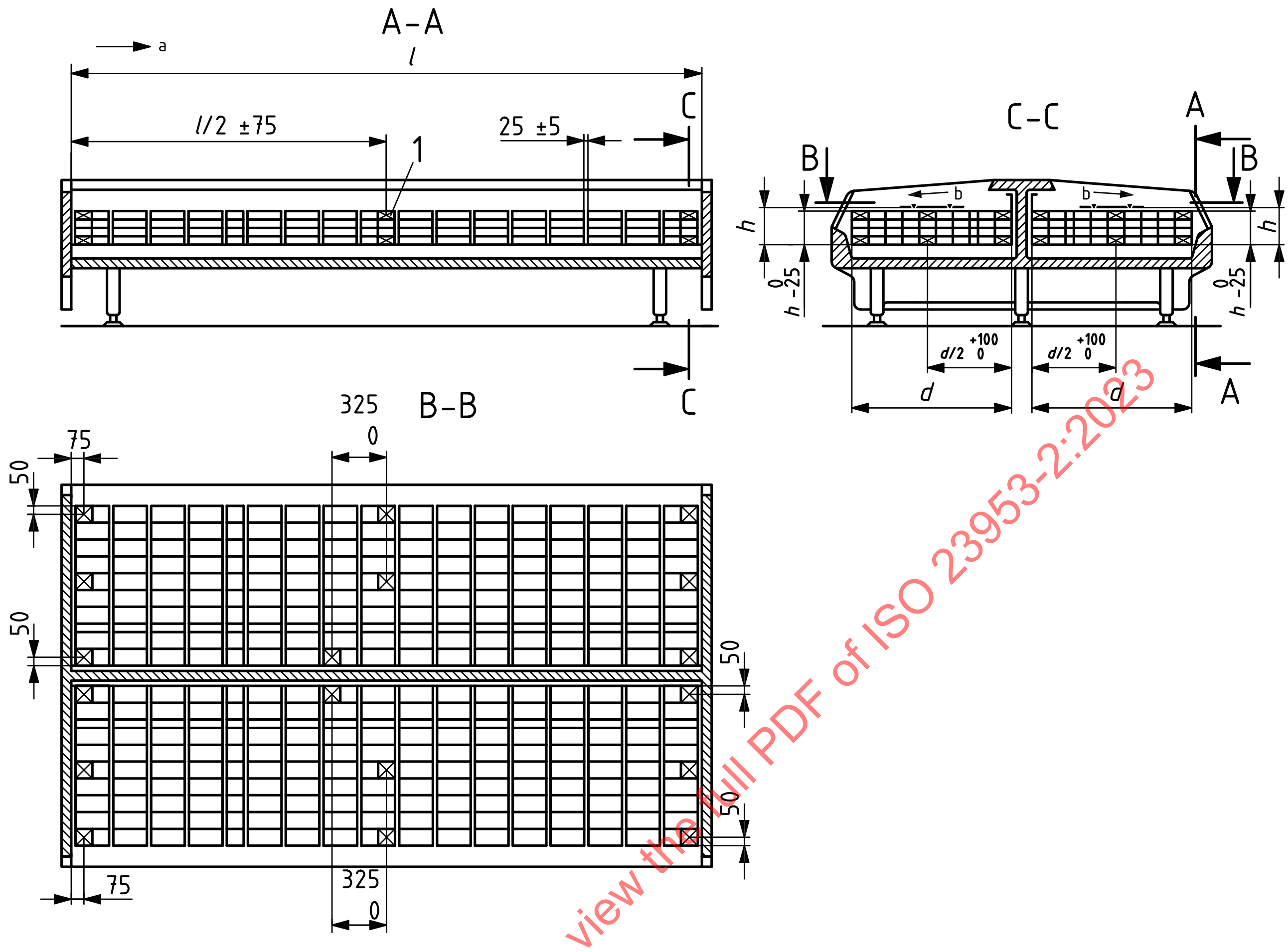
b Direction of air flow.

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

Dimensions in millimetres



a) Island cabinet provided with forced air cooling (horizontal open and closed)



b) Island cabinet with air discharge in the middle

Key

1 M-package

d depth of base deck

h height at load limit

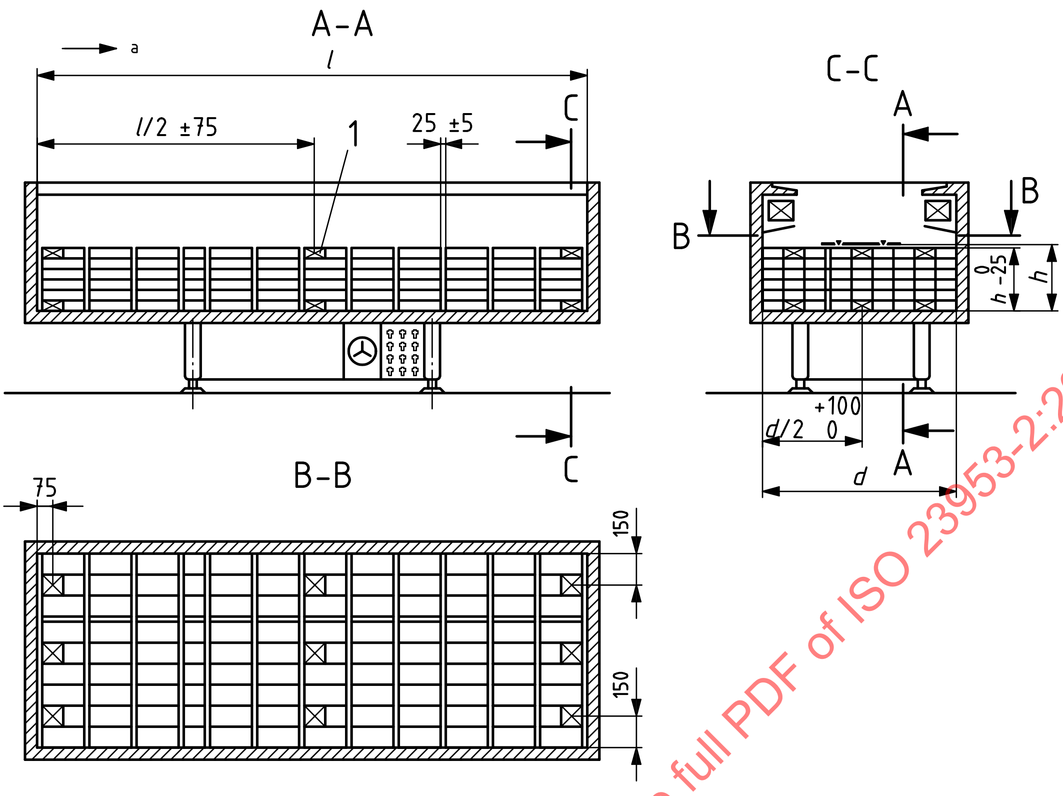
l length of the cabinet

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

[b] Direction of forced air flow.

Figure 15 — Island cabinet provided with forced air cooling (horizontal open and closed) and island with air discharge in the middle

Dimensions in millimetres



Key

1 M-package

d depth of base deck

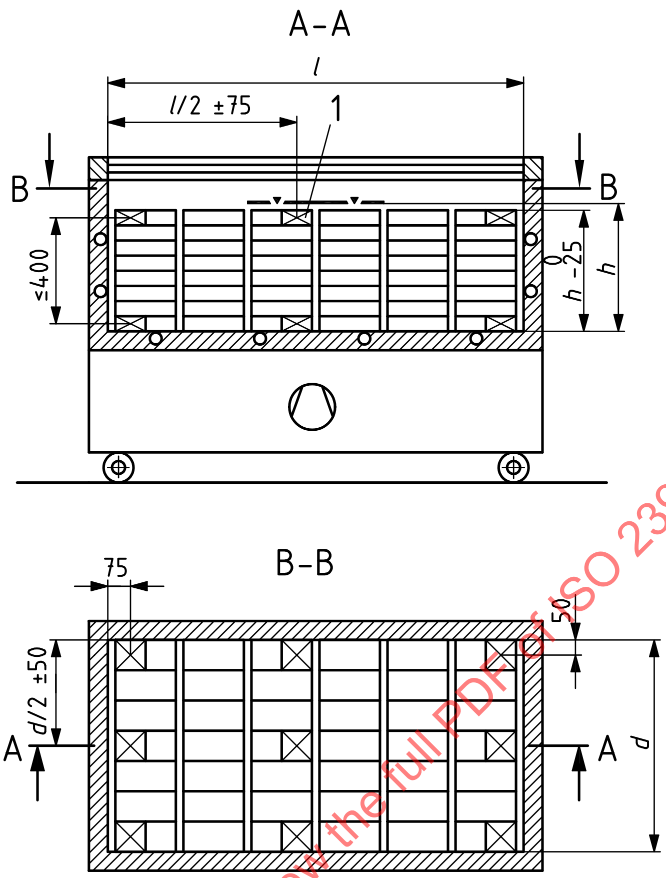
h height at load limit

l length of the cabinet

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

Figure 16 — Island cabinet provided with natural convection cooling (horizontal, open and closed)

Dimensions in millimetres



Key

1 M-package

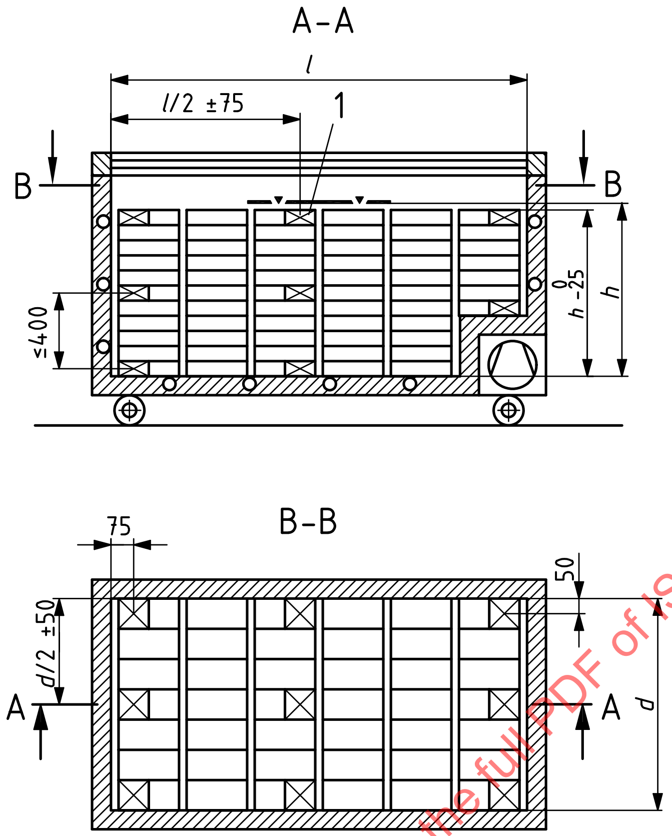
d depth of base deck

h height at load limit

l length of the cabinet

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

Dimensions in millimetres



Key

1 M-package

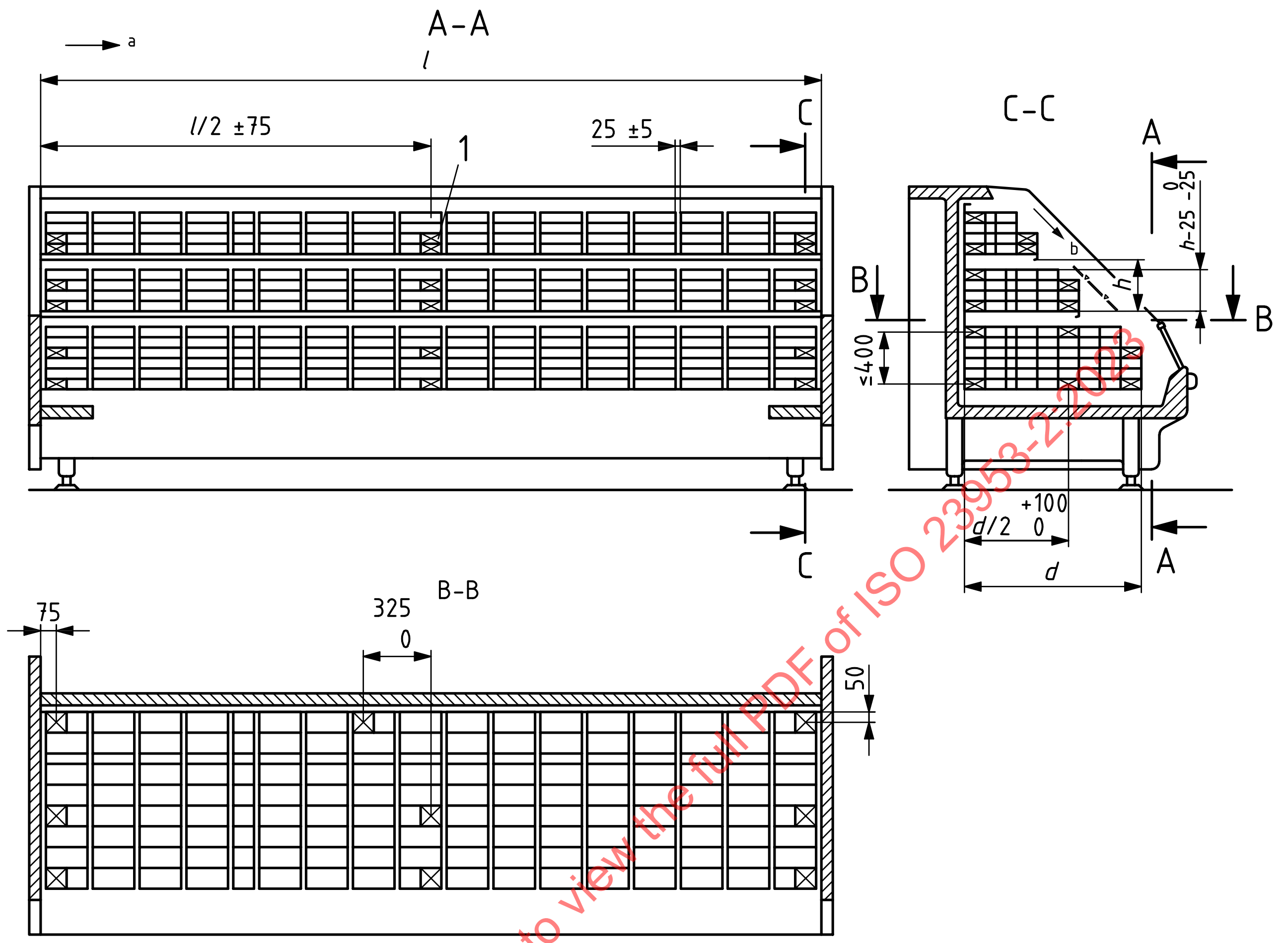
d depth of base deck

h height at load limit

l length of the cabinet

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

Dimensions in millimetres



Key

1 M-package

d depth of base deck

h height at load limit

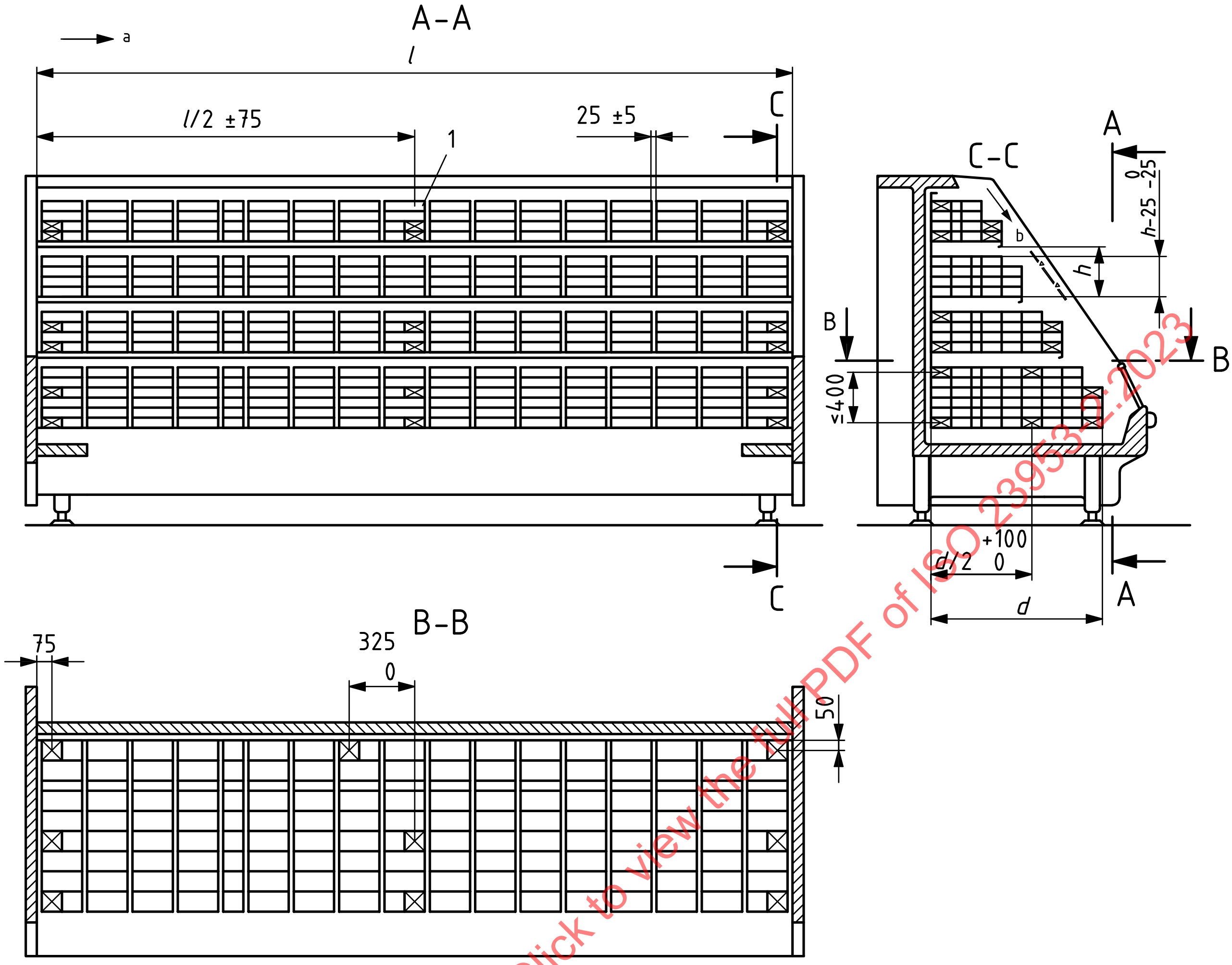
l length of the cabinet

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

b Direction of forced air flow

Figure 19 — Semi-vertical chilled cabinet (2 shelves) provided with forced air cooling (open and closed)

Dimensions in millimetres



Key

1 M-package

d depth of base deck

h height at load limit

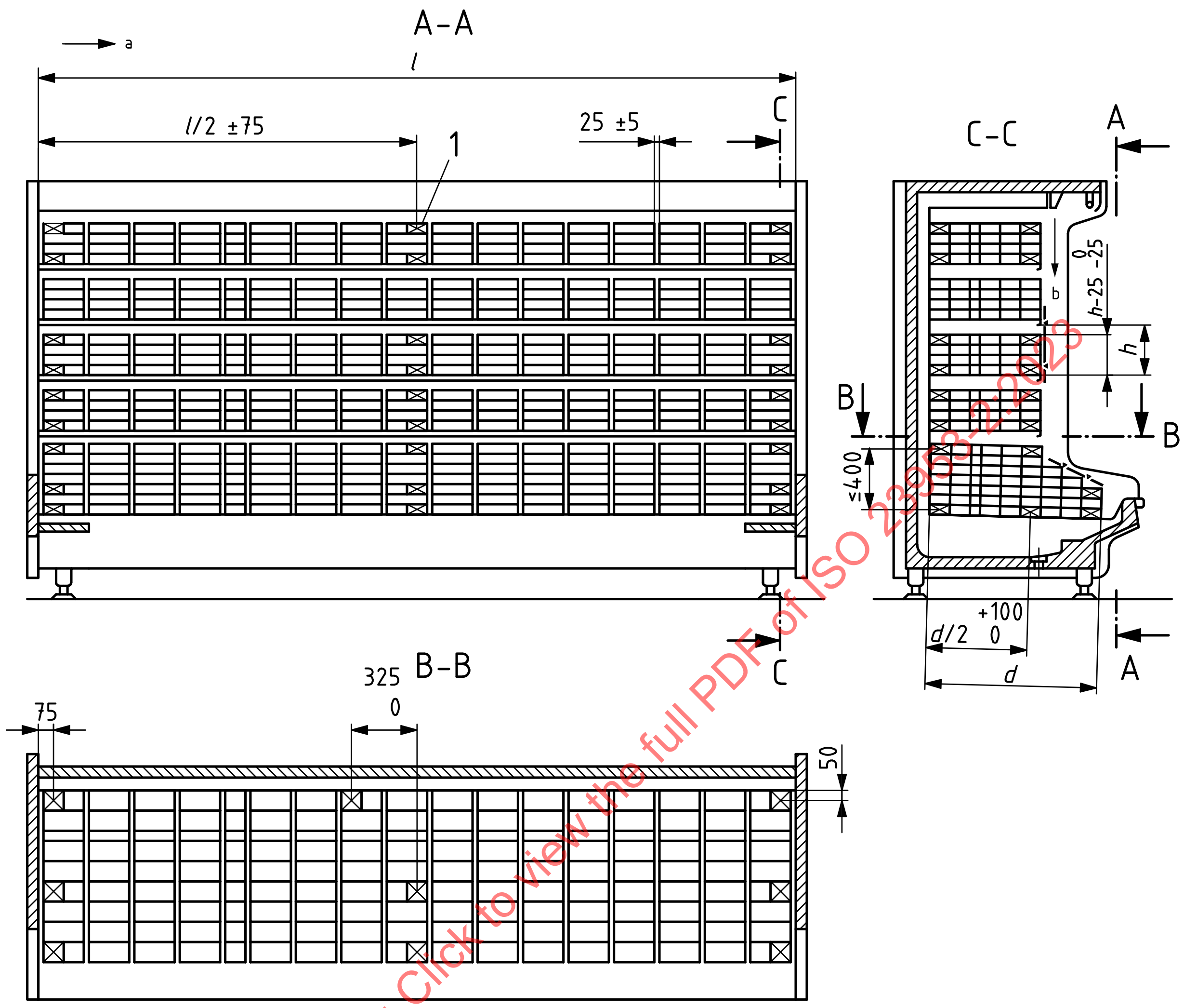
l length of the cabinet

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

b Direction of forced air flow.

Figure 20 — Semi-vertical chilled cabinet (3 shelves) provided with forced air cooling (open and closed)

Dimensions in millimetres



Key

1 M-package

d depth of base deck

h height at load limit

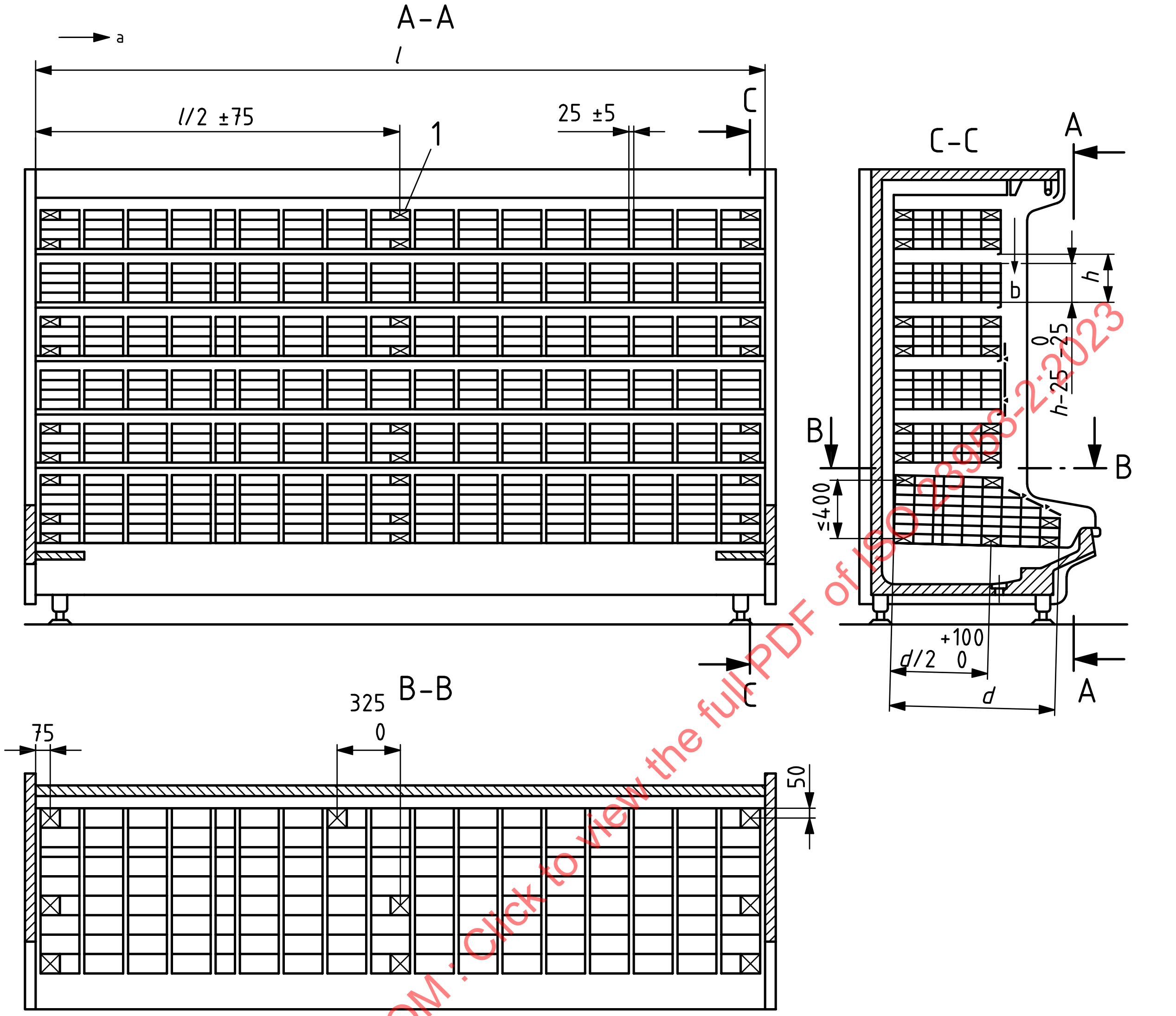
l length of the cabinet

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

b Direction of forced air flow.

Figure 21 — Multi-deck chilled cabinet (4 shelves) provided with forced air cooling (vertical, open and closed)

Dimensions in millimetres



Key

1 M-package

d depth of base deck

h height at load limit

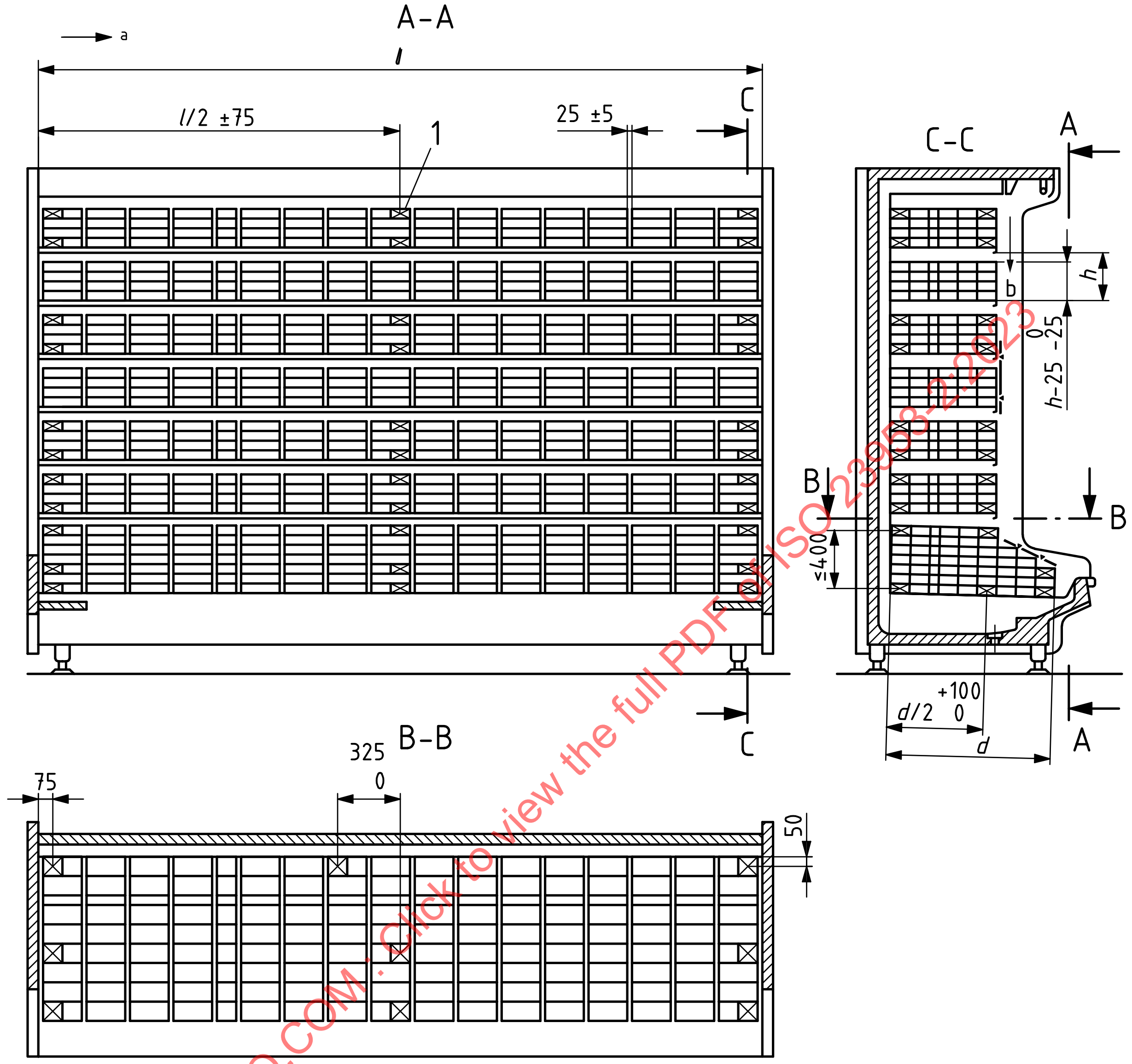
l length of the cabinet

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

b Direction of forced air flow.

Figure 22 — Multi-deck chilled cabinet (5 shelves) provided with forced air cooling (vertical, open and closed)

Dimensions in millimetres



Key

1 M-package

d depth of base deck

h height at load limit

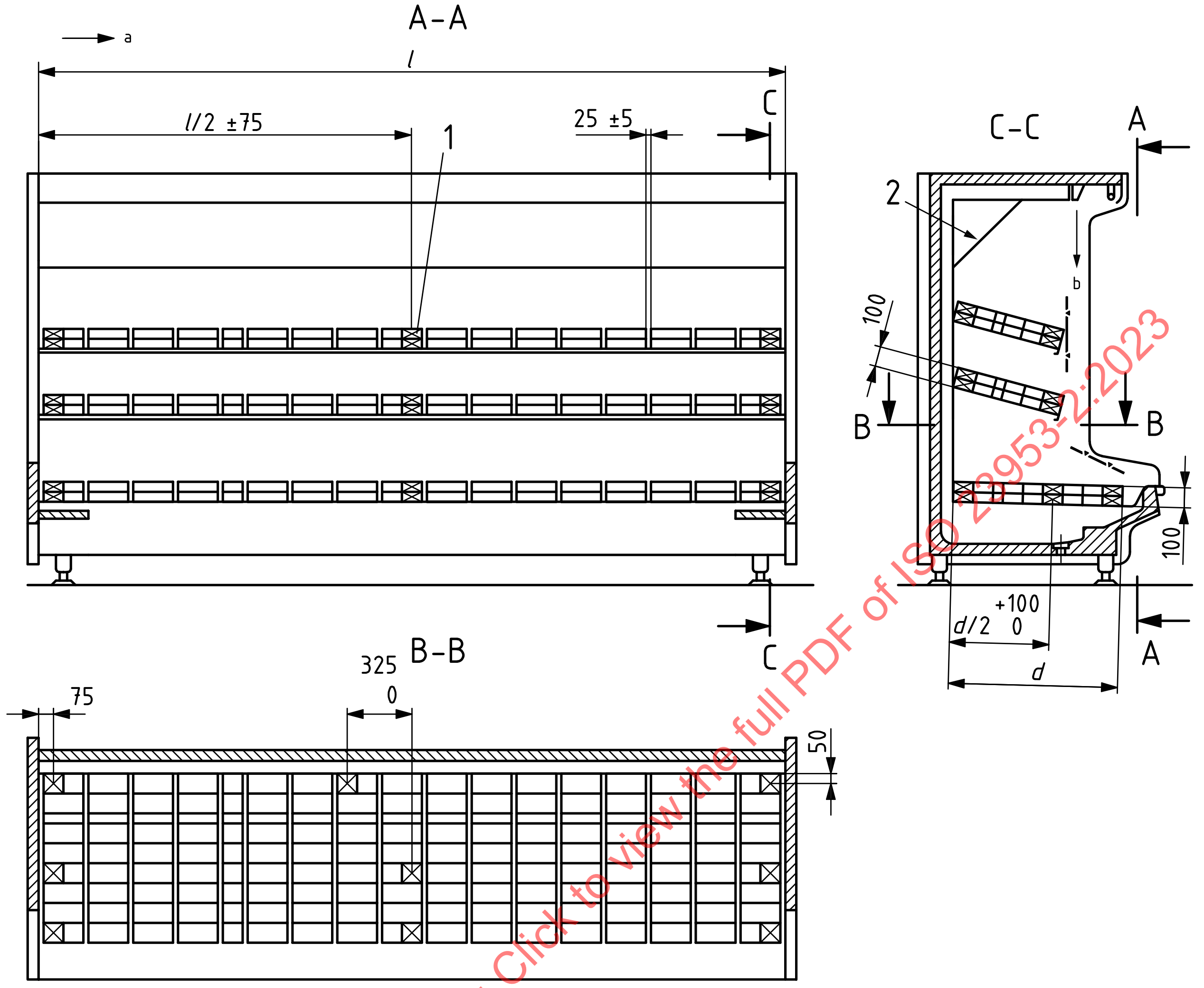
l length of the cabinet

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

b Direction of forced air flow.

Figure 23 — Multi-deck chilled cabinet (6 shelves) provided with forced air cooling (vertical, open and closed

Dimensions in millimetres



Key

1 M-package

2 mirror

l length of cabinet

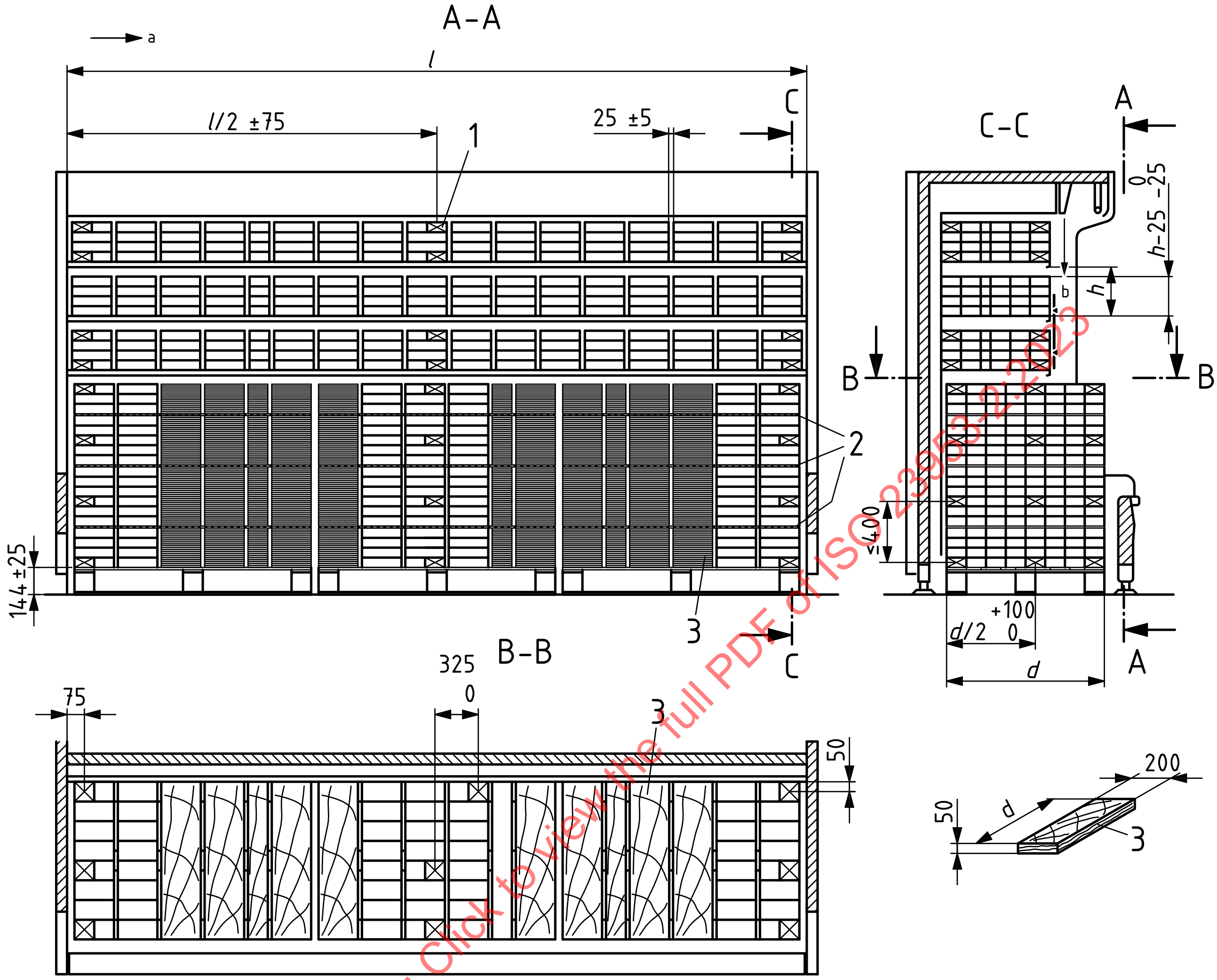
d depth of base deck

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

b Direction of forced air flow.

Figure 24 — Multi-deck chilled cabinet (2 shelves) provided with forced-air cooling for sensitive foodstuffs (vertical, open and closed)

Dimensions in millimetres



Key

1 M-package

2 grids

3 wood loading

d depth of base deck

h height at load limit

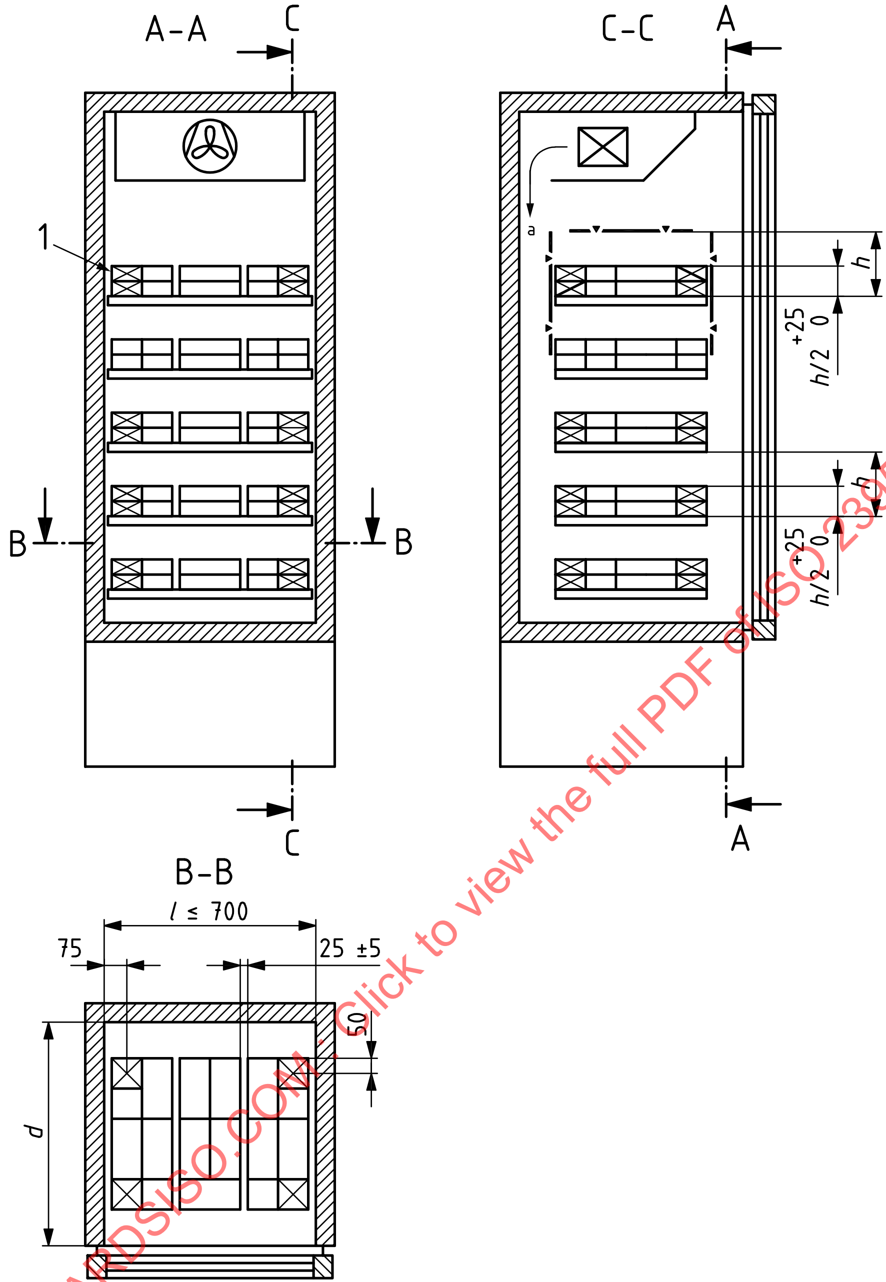
l length of the cabinet

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

b Direction of forced air flow.

Figure 25 — Roll-in and multi-deck chilled cabinet (3 shelves) with high load limit in the base, provided with forced air cooling (vertical, open and closed)

Dimensions in millimetres



Key

1 M-package

l length of cabinet

d depth of base deck

h height at load limit

a Direction of forced air flow.

Figure 26 — Vertical cabinet (4 shelves) with glass door and half shelf loading height

5.3.3.4 Running in

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

Adjustable automatic controllers should 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 should be tested as delivered.

The manufacturer's recommended routine of defrosting should be followed. Before tests are started, the cabinet should 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 should be continued accordingly.

After the running-in period the cabinet shall be filled with test packages and M-packages according to 5.3.3.3 for the tests.

After loading, the cabinet shall be operated until stable conditions have been reached (see 5.3.3.5) and during the test period (see 5.3.3.6) the test room should be maintained at the desired climate class as specified in 5.3.2, while the temperatures of the M-packages are recorded.

5.3.3.5 Stable conditions period

A stable conditions period is necessary before the start of a test period. During the stable conditions period the required M-package temperature class shall be maintained.

For closed refrigerated cabinets, stable conditions shall be achieved and, if the cabinet is fitted with lighting, the lights shall be continuously left switched on and doors closed.

For open refrigerated cabinets fitted with lighting and night-covers, stable conditions shall be achieved with the cabinet continuously opened with the light continuously switched on.

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

During the stable conditions period, changes to the cabinet controller settings and parameters or changes of mechanical adjustment of valves are not allowed.

As an overview of application see Table 7.

5.3.3.6 Test period

After stable conditions have been reached, the test period shall be not less than 24 h for all cabinets.

During the test period the cabinet setting shall be the same used in the stabilisation period.

Changes to the cabinet controller setting and parameter or changes of mechanical adjustment of valve are not allowed.

Automatic setting parameter adaptation by control algorithms e.g. to adapt day and night mode are allowed.

Cabinet with door or lids that were kept closed during the stabilization period the following additional criteria shall be met, to ensure temperatures of M-package are not drifting to higher value due to day by day shifting:

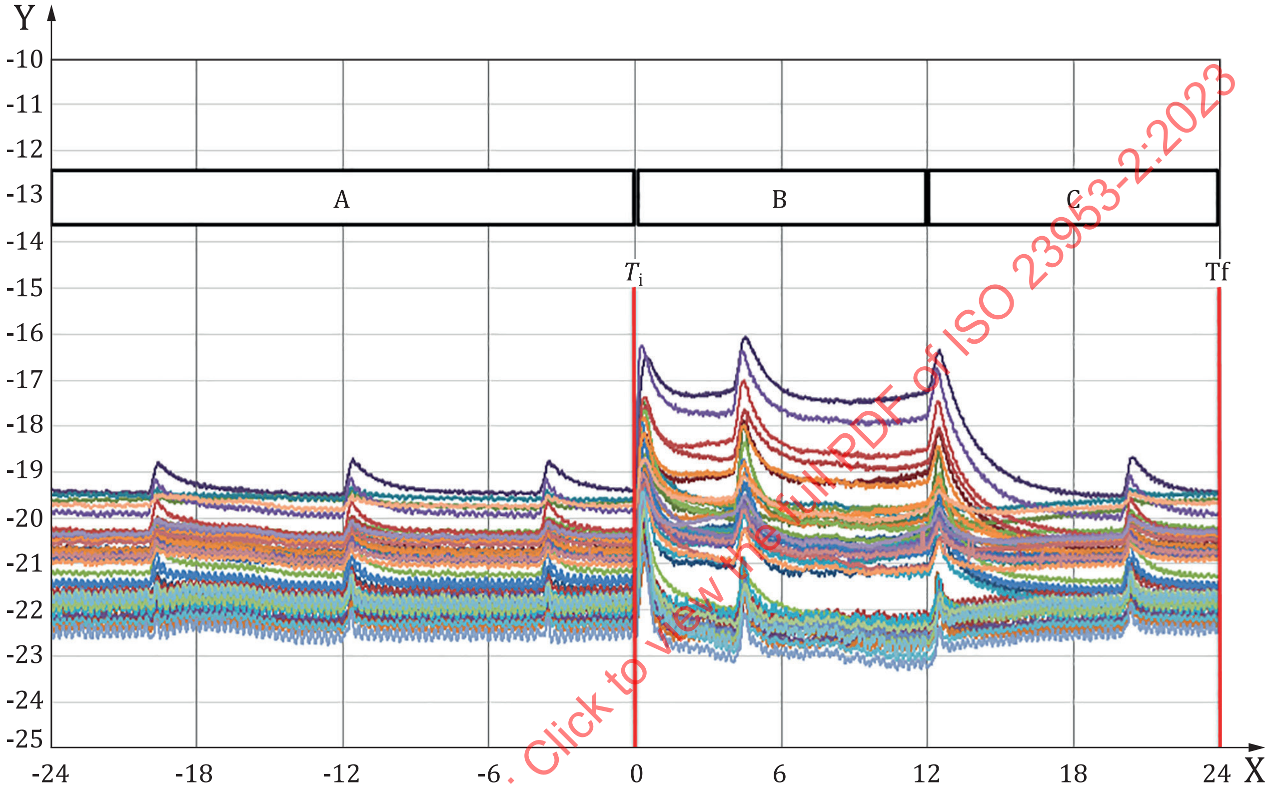
— the temperature of the warmest M-package in the test period measured at the end of a test period (T_f) shall not be +1,0 K higher than its temperature measured at the beginning of the 24 h test period T (T_i), see Figure 27.

— additionally, for closed chilled cabinets the temperature of the coldest M-package in the test period measured at the end of a test period (T_f) shall not be −1,0 K lower than its temperature measured at the beginning of the 24 h test period T (T_i), as shown in Figure 27. This condition shall not be applied to freezer cabinets.

— If these criteria are not met, a second 24 h test period is allowed to verify the criteria is met in this following 24 h period.

— Performance in term of temperature class and energy consumption shall be reported averaging the energy consumption with the second 24 h test period, if carried out or prescribed by the manufacturer.

Open cabinet that make the stabilization with the highest heat gain (open night blind and light on) are not at risk of drift. For this kind of cabinet the additional criteria are not necessary.



Key

X time (h)

Y temperature (°C)

A stable condition period

B 12 h doors opening

C 12 h doors closed

Figure 27 — Example of time temperature diagram showing 24 h test period, (T_f) and (T_i)

As an overview of application see Table 7.

5.3.3.7 Lighting and night-covers

5.3.3.7.1 Lighting

If the test cabinet is fitted with lighting, carry out the tests according to 5.3.4, 5.3.5, 5.3.6 and 5.3.7 as follows a) and/or b) according to the declared performance:

a) leave the cabinet lighting switched on continuously for a period of 24 h;

b) leave the cabinet lighting switched on for a period of 12 h, followed by 12 h with cabinet lighting switched off.

Cabinets without lighting controls shall be tested with the lighting operating continuously.

Lighting control can be manual or automatic internal or external.

5.3.3.7.2 Night-covers

If an open cabinet is provided with night-covers, the 24 h test shall start with 12 h night-covers removed while lights are switched on, followed by 12 h with the night-covers put on while lights are switched off.

In order to facilitate the application of the many configurations related to doors, covers and lights, Table 7 shows an overview of the test schedule in relation to the main accessories use.

Table 7 — Testing sequences for different configurations

<table>
<tr><td>Clause</td><td>5.3.3.5</td><td colspan="8">5.3.3.6</td></tr>
<tr><td>Test phase</td><td>Stable condition period</td><td colspan="8">Test period</td></tr>
<tr><td rowspan="2">Length of time</td><td rowspan="2">24 h minimum</td><td colspan="4">24 h</td><td colspan="4">24 h</td></tr>
<tr><td colspan="3">12 h</td><td>12 h</td><td colspan="3">12 h</td><td>12 h</td></tr>
<tr><td>Cabinet load</td><td>Test package load</td><td colspan="4">Test package load</td><td colspan="4">Test package load</td></tr>
<tr><td rowspan="2">Closed cabinets</td><td>Doors/lids closed</td><td>Load simulation</td><td>Waiting time 5 min</td><td>Door/lid opening cycle</td><td>Doors closed</td><td>Load simulation</td><td>Waiting time 5 min</td><td>Door/lid opening cycle</td><td>Doors closed</td></tr>
<tr><td>Lighting on</td><td colspan="3">Lighting on</td><td>Lighting off</td><td colspan="3">Lighting on</td><td>Lighting off</td></tr>
<tr><td rowspan="2">Open cabinets with night-covers</td><td>Night-covers removed</td><td colspan="3">Night-covers removed</td><td>Night-covers on</td><td colspan="4" rowspan="2"></td></tr>
<tr><td>Lighting on</td><td colspan="3">Lighting on</td><td>Lighting off</td></tr>
<tr><td rowspan="2">Open cabinets w/o night-covers</td><td rowspan="2">Lighting on</td><td colspan="4">Lighting on</td><td colspan="3">Lighting on</td><td>Lighting off</td></tr>
<tr><td colspan="4">5.3.3.7.1 a)</td><td colspan="4">5.3.3.7.1 b)</td></tr>
<tr><td>Electrical energy</td><td></td><td colspan="4">Measure energy consumption</td><td colspan="4">Measure energy consumption</td></tr>
<tr><td>Temp class</td><td>±0,5 K</td><td colspan="4">M-package temperature classification</td><td colspan="4">M-package temperature classification</td></tr>
<tr><td>Temp drift</td><td></td><td colspan="4">Not more than 1 K on closed chillers</td><td colspan="4">Not more than 1 K on closed chillers</td></tr>
<tr><td>Warmest M-package</td><td></td><td colspan="3">T_{i1}</td><td>T_{f1}</td><td colspan="3">T_{i2}</td><td>T_{f2}</td></tr>
<tr><td>Coldest chiller M-package</td><td></td><td colspan="3">T_{i1}</td><td>T_{f1}</td><td colspan="3">T_{i2}</td><td>T_{f2}</td></tr>
</table>

5.3.3.8 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).

5.3.3.9 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.

5.3.3.10 Power supply

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

5.3.3.11 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 5.3.2 to 5.3.3.

5.3.4 Temperature test

5.3.4.1 Test conditions

The cabinet shall be located and loaded in accordance with 5.3.2 and 5.3.3, operated in accordance with the manufacturer's instructions at the conditions appropriate to the test room climate class for which it is intended (see 5.3.2.4.1), and then operated for the test period defined in 5.3.3.6, during which measurements shall be recorded. Lighting, and night-covers, if any, shall be manipulated according to 5.3.3.7.

The test shall begin after the stabilisation period and not during a defrost period.

The defrosts shall be scheduled according to the manufacturer's instructions.

During the temperature test any manual reset protective devices shall not be reset.

5.3.4.2 Closed refrigerated cabinets

The test for closed refrigerated cabinets shall always be carried out on the complete cabinet, regardless of the number of doors or lids. Within the test period, assisted service and self-service doors or lids shall be opened cyclically for 12 h within 24 h. Doors that are only used for maintenance, cleaning or a door(s) for loading of food into the cabinet shall not be opened during this test.

The 12 h cycle of door or lid opening shall start at the beginning of the test period.

For closed cabinets, only the test of 5.3.3.7.1 b) is required.

At the start of the 12 h period of the test period T, and before starting of the door opening cycle, each door or lid shall be opened once for 3 min to simulate the loading of foodstuff. Where a cabinet is provided with more than one door or lid, each door or lid shall be opened once for 3 min consecutively.

After the loading simulation all doors shall be closed for 5 min before starting the door opening cycle.

Each door and/or lid shall be opened for frozen food applications six times per hour, while for chilled food applications, each shall be opened 10 times per hour.

Where more than one door or lid pertains to the cabinet under test, doors shall be opened in sequence from left to right and top to bottom, as depicted in Figure 28.

Examples of door opening for two doors frozen and chilled applications are reported in Table 8 and Table 9.

Table 8 — Example for two doors frozen food applications

Action starting time [min]	Action on door 1	Action on door 2
0	open door 1 for 3 minutes to simulate loading	no action, keep door closed
3	close door 1	open door 2 for 3 minutes to simulate loading
6	no action, keep door closed	close door 2
11	open door 1	no action, keep door closed
16	no action, keep door closed	open door 2
21	open door 1	no action, keep door closed
26	no action, keep door closed	open door 2
31	open door 1	no action, keep door closed
36	no action, keep door closed	open door 2
41	open door 1	no action, keep door closed
46	no action, keep door closed	open door 2
...		

Table 9 — Example for two doors chilled food applications

Action starting time [min]	Action on door 1	Action on door 2
0	open door 1 for 3 minutes to simulate loading	no action, keep door closed
3	close door 1	open door 2 for 3 minutes to simulate loading
6	no action, keep door closed	close door 2
11	open door 1	no action, keep door closed
14	no action, keep door closed	open door 2
17	open door 1	no action, keep door closed
20	no action, keep door closed	open door 2
23	open door 1	no action, keep door closed
26	no action, keep door closed	open door 2

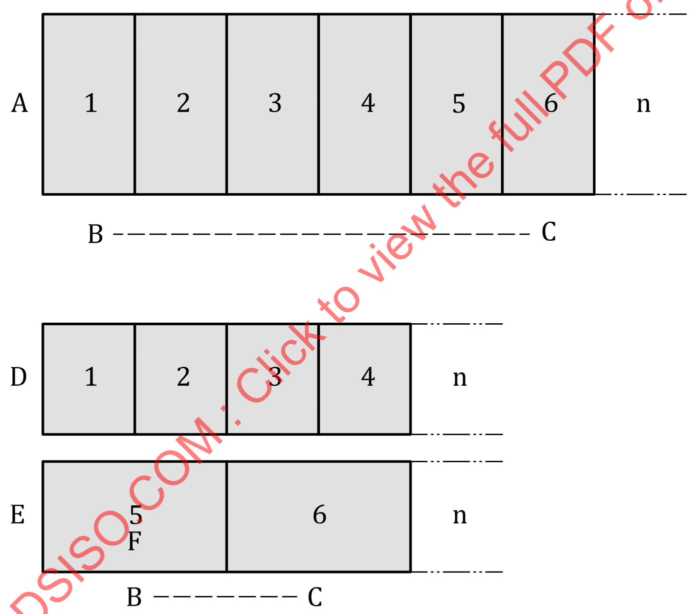
Table 9 *(continued)*

Action starting time [min]	Action on door 1	Action on door 2
29	open door 1	no action, keep door closed
32	no action, keep door closed	open door 2
...		

Hinged lids and doors shall be opened beyond an angle of 60°. Sliding glass doors or lids shall be opened beyond 80 % of the maximum area which can be opened.

For frozen food applications, the door or lid shall be opened for a total of 6 s, while for chilled food applications, the door or lid shall be opened for a total of 15 s. During this opening period, the doors or lids shall be kept open beyond the minimum required opening, that is 4 s for frozen food applications and for 13 s for chilled food applications.

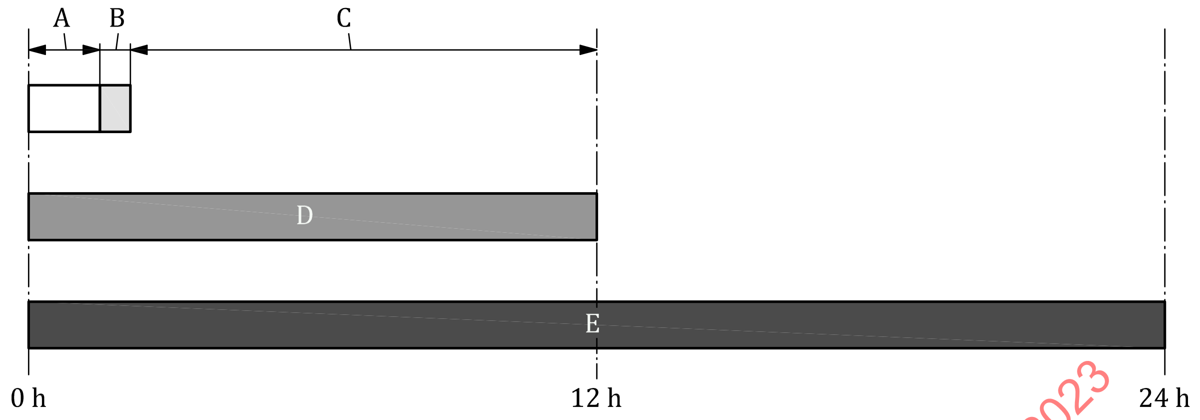
Figure 29 depicts the door opening sequence schedule.



Key

A VF4/VC4 cabinet (front view)
B left facing cabinet
C right facing cabinet
D YF4/YC4 cabinet (front view)
E top view
F sliding lid

Figure 28 — Example of door opening sequence



Key

A loading simulation door opening period

B waiting time 5 min

C door opening cycle

D door opening period

E test period

Figure 29 — Door opening schedule

5.3.4.3 Island with air discharge in the middle

5.3.4.3.1 The test for island with air discharge in the middle shall consider the following design variations:

a) one chest, parts of the air distribution (fans, air ducts) and/or the refrigeration system (evaporator) are used for both sides of the cabinet;

b) one chest, air distribution and refrigeration system are completely separated; the sides of the island are equal and symmetric; all electrical components (fan motors, anti-sweat heaters, defrost heaters), the evaporators and thermostatic expansion valves are the same in each refrigerated volume, and the temperature control system, such as the defrost control system, are symmetrically mounted and independently operative in each specific refrigerated volume.

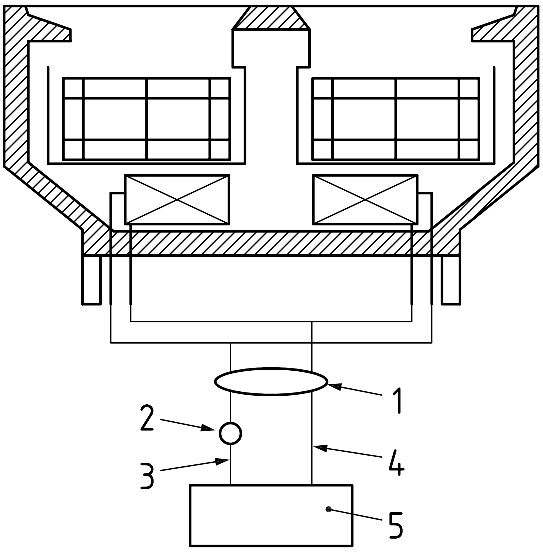
Test procedure:

— For design variation a)

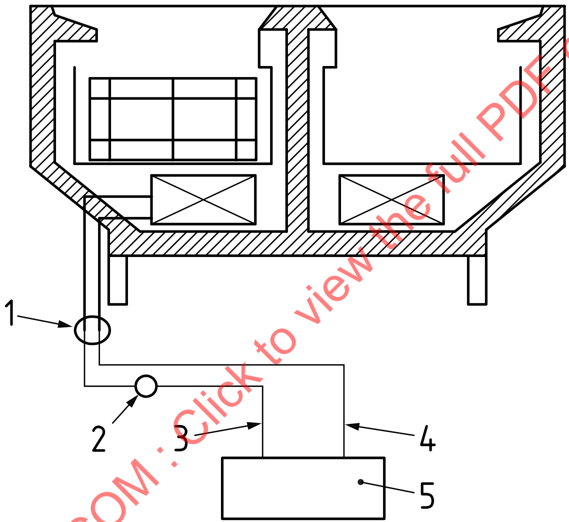
The piping has to be organized in such a way that the whole cabinet is connected to a single refrigeration plant by one main liquid and one main suction line. Even if the island has two evaporators with separate piping, the suction and the liquid lines shall be connected to two main lines (one suction, one liquid line) inside or outside the cabinet. All temperatures, pressure and mass flow measurements of the refrigerant shall be taken on the main lines. The piping shall be thermally insulated from the cabinet outlet to the locations where the measurements are taken. Both sides of the cabinet shall be loaded with M-packages and the temperature from both sides shall be monitored [see Figure 30 a)].

— For design variation b)

Only one side of the cabinet may be tested considering it like a single case. Only the tested side(s) shall be loaded with M-packages and connected to the refrigerant plant [see Figure 30 b)].



a) Design variation a)



b) Design variation b)

Key

1 temperature and pressure measurements as in a single case (see 5.3.7.2.1 and Figure 32)
2 refrigeration mass flow meter (see 5.3.7.2.1 and Figure 32)
3 liquid supply (see 5.3.7.2.1 and Figure 32)
4 vapour return (see 5.3.7.2.1 and Figure 32)
5 condensing unit

Figure 30 — Island with air discharge in the middle

5.3.4.3.2 As far as $E_{DEC,24h}$ and $E_{REC,24h}$ measurement and calculations are concerned (see 5.3.7), the following shall be considered.

— For design variations b), single side test:

the total value of $E_{REC,24h}$ is double the value calculated for the single side tested;

the total value of $E_{DEC,24h}$ is double the value calculated for the single side tested.

— For design variations b), double side tests, follow design variation a).

— For the calculation of S_{TDA}, see Figure A.15.

5.3.4.4 Temperature curves of M-packages

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

For frozen cabinets:

1) the temperature of the warmest M-package (i.e. the one with the highest peak temperature during defrost or door opening θ_{ah}) (see curve a in Figure 31);

2) the temperature that during test period T, excluding the periods during defrost or during the door openings, presents the highest minimum value θ_{al} (see curve c i Figure 31 a);

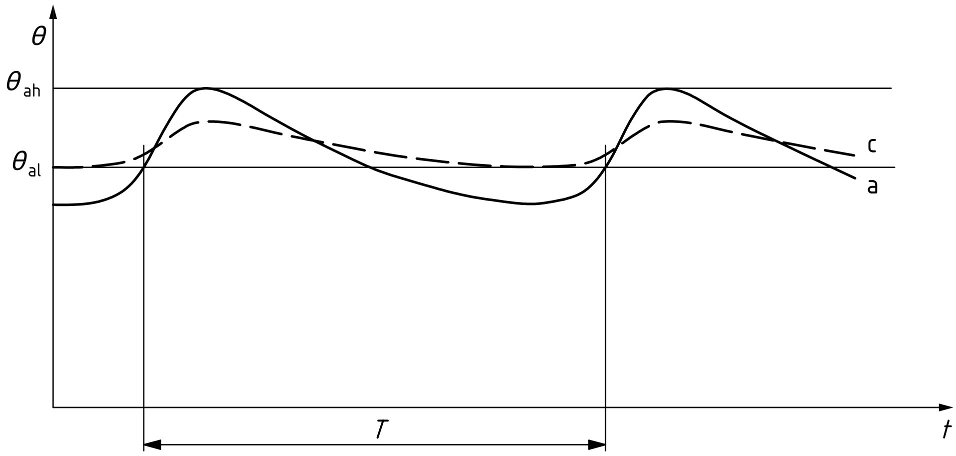
For chilled cabinets:

3) the temperature of the warmest M-package (i.e. the one with the highest peak temperature θ_{ah}) (see curve a in Figure 31 b);

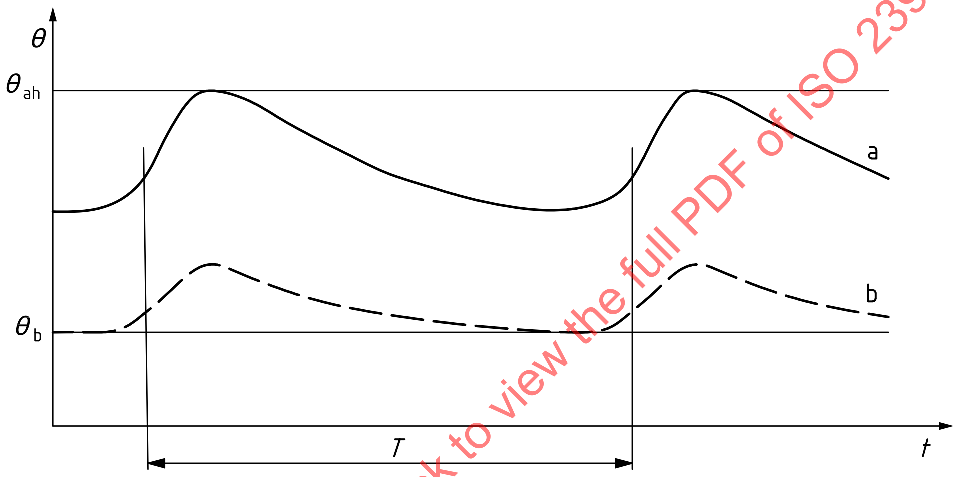
4) the temperature of the coldest M-package (i.e. the one with the lowest minimum temperature θ_b) (see curve b in Figure 31 b).

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.



a) Temperature curve with the highest minimum value of all M-package



b) Temperature curve of coldest M-package

Key

θ	temperature
θ_{ah}	highest temperature of warmest M-package
θ_{b}	lowest temperature of coldest M-package [for chilled cabinets only; see 4.2.2 (Table 1)]
θ_{al}	temperature that during test period T, excluding the periods during defrost or during the door openings, presents the highest minimum value see 4.2.2 (Table 1)
t	time
T	test period
a	temperature curve of warmest M-package
b	temperature curve of coldest M-package
c	temperature curve with the highest minimum value of all M-package

Figure 31 — Relevant temperature curves of M-package

5.3.4.5 Calculation of average mean temperature

The average instant temperature at measuring sample n of all M-packages, θ_{cn} (curve d in Figure 32), is expressed by the Formula (2):

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

where

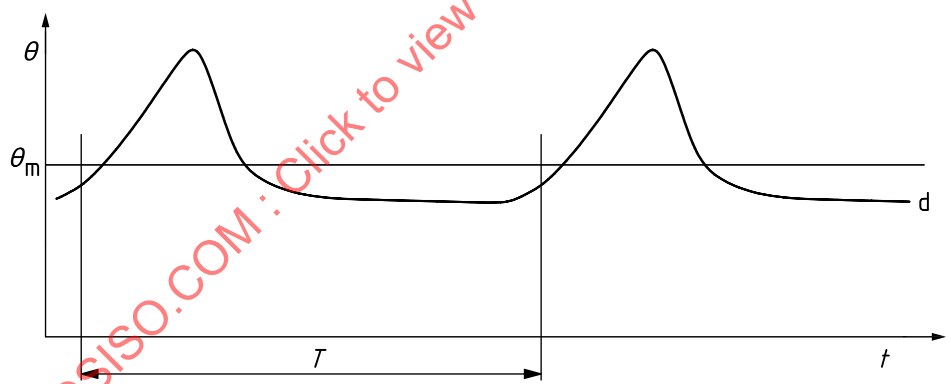
n	is the time index for the instant measuring sample;
k	is the index for the individual M-package;
K_{maxc}	is the number of all M-packages;
$(\theta_k)_n$	is the instant measured temperature of M-package k at measuring sample n.

From these average instant temperatures, the arithmetic mean temperatures of all M-packages θ_m for the test period shall be calculated as Formula (3):

$$\theta_{\text{m}} = \frac{1}{N_{\text{max}}} \times \sum_{n=1}^{N_{\text{max}}} \theta_{cn} \quad (3)$$

where N_{max} is the number of measuring samples taken during the test period.

The formula is valid only for constant time intervals during the test period.



Key

θ temperature
θ_{m} average mean temperature
t time
T test period
d curve of arithmetic mean temperature of all M-packages

Figure 32 — Arithmetic mean temperature of M-packages

The arithmetic mean temperature of M-packages curve d shall be plotted together with curves a, b and c and separately for each temperature class in the case of cabinets with multiple temperature classes.

5.3.4.6 Rounding of temperature classification measurements

For temperature classification M-packages temperatures shall be reported to the nearest integer as prescribed in Table 1 (0,5 shall be rounded up).

EXAMPLE 4,4 °C is rounded to 4 °C and 4,5 °C is rounded to 5 °C.

5.3.5 Water vapour condensation test

5.3.5.1 Test conditions

The cabinet shall be located and loaded in accordance with 5.3.2 and 5.3.3, operated in accordance with the manufacturer's instructions at the conditions appropriate to the test room climate class for which it is intended (see Table 3), and then operated for the test period according to 5.3.3.6, during which measurements shall be recorded. Lighting and night-covers, if any, shall be manipulated according to 5.3.3.7. The test may be carried out during the temperature test and in conjunction with 5.3.6.

Cabinets with manually controlled anti-condensation heaters shall be operated with the heaters switched on unless the manufacturer's instructions clearly state the relevant climate class conditions under which their operation is not required and can remain switched off.

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.

5.3.5.2 Test requirements

The cabinet shall comply with the requirements of 4.2.4.

Verification shall be done by visual inspection of the following items:

a) all external cabinet surfaces remain free of running water resulting in dripping onto the floor

b) water dripping onto any test package or wetting by surface contact

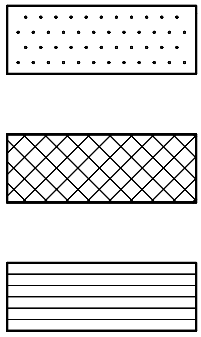
c) transparent panels for viewing displayed product such as doors, lids or windows remain clear of running water. Intermittent misting only is allowed.

NOTE 1 Condensation forming intermittently on external cabinet surfaces is a possible result of variation in test room airflow, humidity and temperature.

NOTE 2 During defrost or during door/ lid opening, it is possible that mirrors doors and transparent side walls periodically mist. They will clear once the refrigeration system operates or doors/ lids are closed.

5.3.5.3 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 photograph or alternatively 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 33 shall be used.



Key

F fog/mist

D droplets

R running water

Figure 33 — Condensation code

5.3.6 Electrical energy consumption test

5.3.6.1 Test conditions

The cabinet shall be located and loaded in accordance with 5.3.2 and 5.3.3, operated in accordance with the manufacturer's instructions at the conditions appropriate to the test room climate class for which it is intended (see Table 3), and then operated for the test period according to 5.3.3.6, during which measurements shall be recorded. Lighting and night-covers, if any, shall be manipulated according to 5.3.3.7.

The test shall be carried out during the temperature test.

During the energy consumption test any manual reset protective devices shall not be reset.

5.3.6.2 Cabinets fitted with incorporated air cooled or incorporated liquid cooled condensing unit

5.3.6.2.1 Cabinets fitted with incorporated air-cooled condensing unit

For cabinets with an incorporated air-cooled condensing unit the direct daily electrical energy consumption ($E_{DEC,24h}$) equals the total energy consumption (E_{TEC}) over a 24 h period, as it includes the condensing unit energy consumption. Refrigeration electrical energy consumption ($E_{REC,24h}$) over a 24 h period is not defined for these cabinets.

E_{TEC} measurement shall be carried out as specified in Annex D (this includes all cabinet electrical items, for example compressor, fans, lighting, controllers, defrost heaters). The E_{TEC} over a 24 h period shall be reported in kWh with all fitted electrical power-using components switched on.

5.3.6.2.2 Cabinets fitted with incorporated liquid cooled condensing unit

5.3.6.2.2.1 General

For cabinets with an incorporated liquid cooled condensing unit the total daily energy consumption (E_{TEC}) is equal to the direct daily electrical energy consumption ($E_{DEC,24h}$) plus the heat removal energy consumption (E_{HREC}).

$E_{DEC,24h}$ measurement shall be carried out as specified in Annex D (this includes all cabinet electrical items, for example compressor, fans, lighting, controllers, defrost heaters). The $E_{DEC,24h}$ shall be reported in kWh with all fitted electrical power-using components switched on.

5.3.6.2.2.2 Heat removal energy consumption (E_{HREC})

The E_{HREC} for a cabinet with an incorporated liquid cooled condensing unit shall be measured during the temperature test.

The E_{HREC} is defined as the contribution of the cooling system (dry cooler) and energy consumption of the pump(s):

$E_{HREC} = E_{CSEC} + E_{CPEC,24h}$

where

E_{CSEC} is the cooling system energy consumption;

$E_{CPEC,24h}$ is the energy consumption of the pump(s).

The inlet and outlet temperatures of the cooling liquid at the condenser shall be measured using temperature sensors directly inserted into the pipe or inserted into pockets (and not 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.

The sensor cables shall be arranged such that external influences on the connection cables are eliminated by the use of insulation.

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

Test conditions:

— Liquid coolant composition: water with 40 % ± 5 % propylene glycol or water according to the manufacturer's specification. The coolant composition shall be reported in the test report.

— The liquid inlet temperature θ_{in} shall be maintained constant at 30 °C ± 1K

— The pump shall run continuously during the test and provide a constant mass flow rate (in kg/h) within ±3 % of that declared by the manufacturer.

  The declared mass flow rate shall be reported in the technical documentation and in the test report.

— The liquid outlet temperature: θ_{out}: measured 5 min after at least one compressor starts the temperature difference between brine inlet and outlet shall be at least 3K.

— Accuracy on θ_{out} - θ_{in} measurement shall be ±0,1 K

E_{CSEC} is calculated with the Formula (4):

$$E_{CSEC} = P_{fact} \cdot \sum_{n=1}^{N_{max}} \left(q_{L,n} \cdot \left(c_{p,out} \cdot \theta_{out,n} - c_{p,in} \cdot \theta_{in,n} \right) \Delta t \right) \quad (4)$$

where

$\theta_{in,n}$ is the instant liquid inlet temperature;

$\theta_{out,n}$ is the instant liquid outlet temperature;

$q_{L,n}$ is the instant value of the mass flow of liquid coolant in kg/s;

$c_{p,in}$ and $c_{p,out}$ are so close that it can be assumed to assign them the same value c_p as below:
for water with 40 % ± 5 % propylene glycol a c_p value of equal to 3,7 kJ / (kg·K) shall be applied,
for pure water a c_p value of equal to 4,2 kJ / (kg·K) shall be applied;

P_{fact} cooling system factor = 0,007

The maximum sampling period shall be 180 s.

NOTE 0,007 is based on a highly energy efficient dry cooler design.

The pumping electrical energy consumption is not measured and is dependent on the practical design of the cooling liquid circuit.

As a conventional rule, the pumping daily energy consumption ($E_{CPEC,24h}$) in kWh is calculated using the following Formula (5); assuming a pressure drop in the system equalling 2,5 times the pressure drop over the cabinet and a pump efficiency of 0,5.

$$E_{CPEC,24h} = \sum_{n=1}^{N_{max}} \frac{2,5 v q_{L,n} \left(P_{irun,n} - P_{orun,n}\right)}{0,5} \Delta t \quad (5)$$

where

$p_{irun,n} - p_{orun,n}$ is the instant value of pressure drop between inlet and outlet of cabinet during t_{run}, in kPa;

$q_{L,n}$ is the instant value of the mass flow of liquid coolant during test period in kg/s. The maximum sampling period shall be 180 s.

The E_{HREC} shall be determined from temperature, pressure and flow rate readings which allow a resultant accuracy of ±5 %.

5.3.6.2.3 Hybrid cabinets with incorporated liquid and air-cooled condensing unit

Hybrid cabinets with incorporated liquid cooled condensing unit which are also able to operate as air-cooled condensing unit shall be tested in both air-cooled and liquid-cooled modes.

5.3.6.3 Cabinets with remote condensing unit

For cabinets with a remote condensing unit the $E_{DEC,24h}$ does not include the $E_{REC,24h}$ which shall be determined in accordance with 5.3.7.

Measure the $E_{DEC,24h}$ of the cabinet only, with all fitted electrical power-using components switched on.

The $E_{DEC,24h}$ recorded for each test shall be the summation of all electrical energy consumed by the refrigerated cabinet during the test period, without the control unit and, for indirect type refrigerating system, including the pump energy consumption $E_{CPEC,24h}$.

NOTE If, for technical reasons, it is too difficult to measure separately the component powers, it is possible to use the $E_{DEC,24h}$ directly measured or the power consumed by any group of single components.

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

5.3.7.1 Test conditions

5.3.7.1.1 General

The cabinet shall be located and loaded in accordance with 5.3.2 and 5.3.3, operated in accordance with the manufacturer's instructions at the conditions appropriate to the test room climate class for which it is intended (see Table 3), and then operated for the test period according to 5.3.3.6, during which measurements shall be recorded. Lighting and night-covers, if any, shall be manipulated according to 5.3.3.7.

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 wall [see Figures 34 a) and 35 a)].

Where thermocouples or similar devices are utilized, 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 ±5 %.

5.3.7.1.2 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 34 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 °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.

5.3.7.1.3 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 35 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.

5.3.7.2 Determination of heat extraction rate

5.3.7.2.1 Cabinets intended for connection to compression-type refrigerating systems

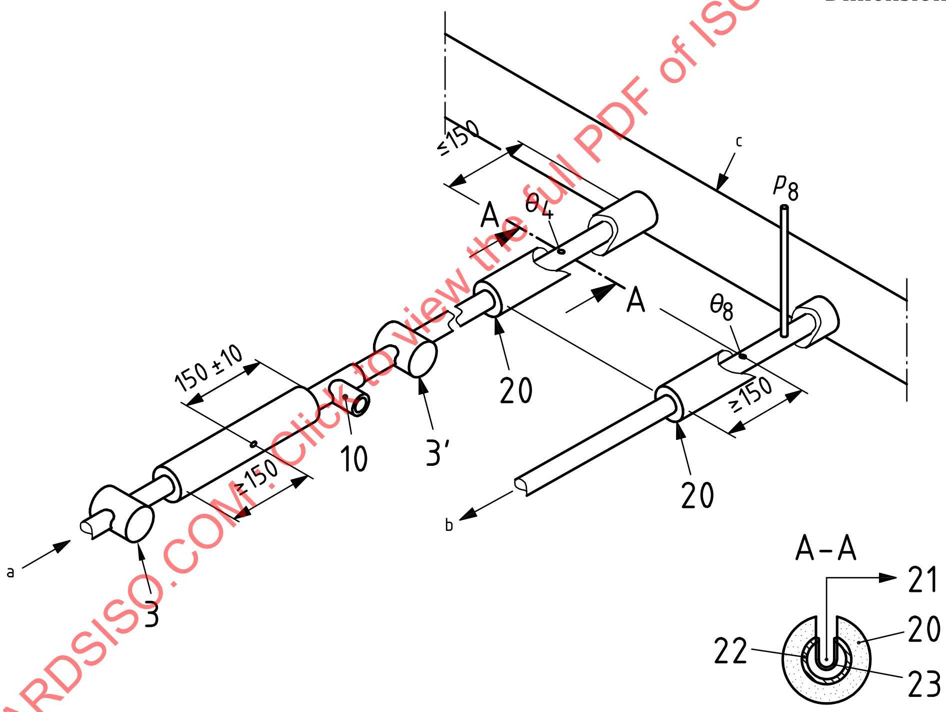
See Figure 35 a).

The instant heat extraction rate in kW is defined as in Formula (6):

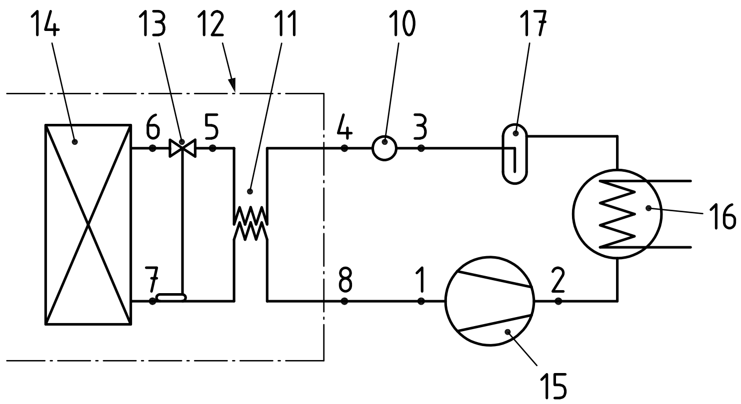
$$\Phi_n = q_m (h_8 - h_4) \tag{6}$$

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

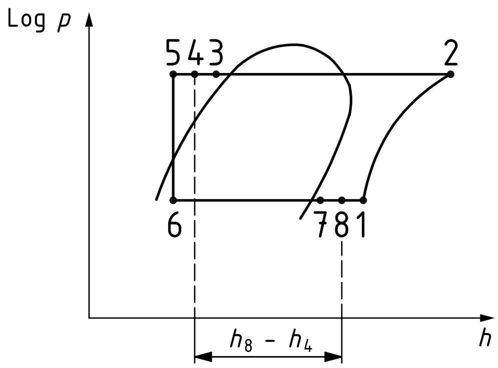
Dimensions in millimetres



a) Connection to remote compression-type refrigerating system



b) Connection to remote compression-type refrigerating system



c) Pressure enthalpy diagram showing points referred to in Figure 34 b)

Key

1	compressor inlet	13	expansion device
2	compressor outlet	14	evaporator
3	sight glass location for subcooled liquid state upstream flow meter	15	compressor
3'	sight glass, optional for subcooled liquid state downstream flow meter	16	condenser
4	measurement point at the cabinet inlet	17	liquid receiver
5	expansion device inlet	20	insulation (to at least 150 mm from temperature sensor)
6	expansion device outlet and inlet of the evaporator	21	to temperature recorder
7	outlet of the evaporator and superheat measurement of the evaporator	22	refrigerant circulation pipe
8	measurement point at the outlet of the cabinet	23	copper thermo-pocket for housing the temperature sensor (shall be filled with glycerine or a similar fluid)
10	refrigerant mass flow meter	a	Liquid supply.
11	fluid vapour heat exchange, if any	b	Vapour return.
12	cabinet	c	Cabinet wall.

Figure 34 — Cabinets intended for connection to compression-type refrigerating systems

5.3.7.2.2 Cabinets intended for connection to indirect-type refrigerating systems

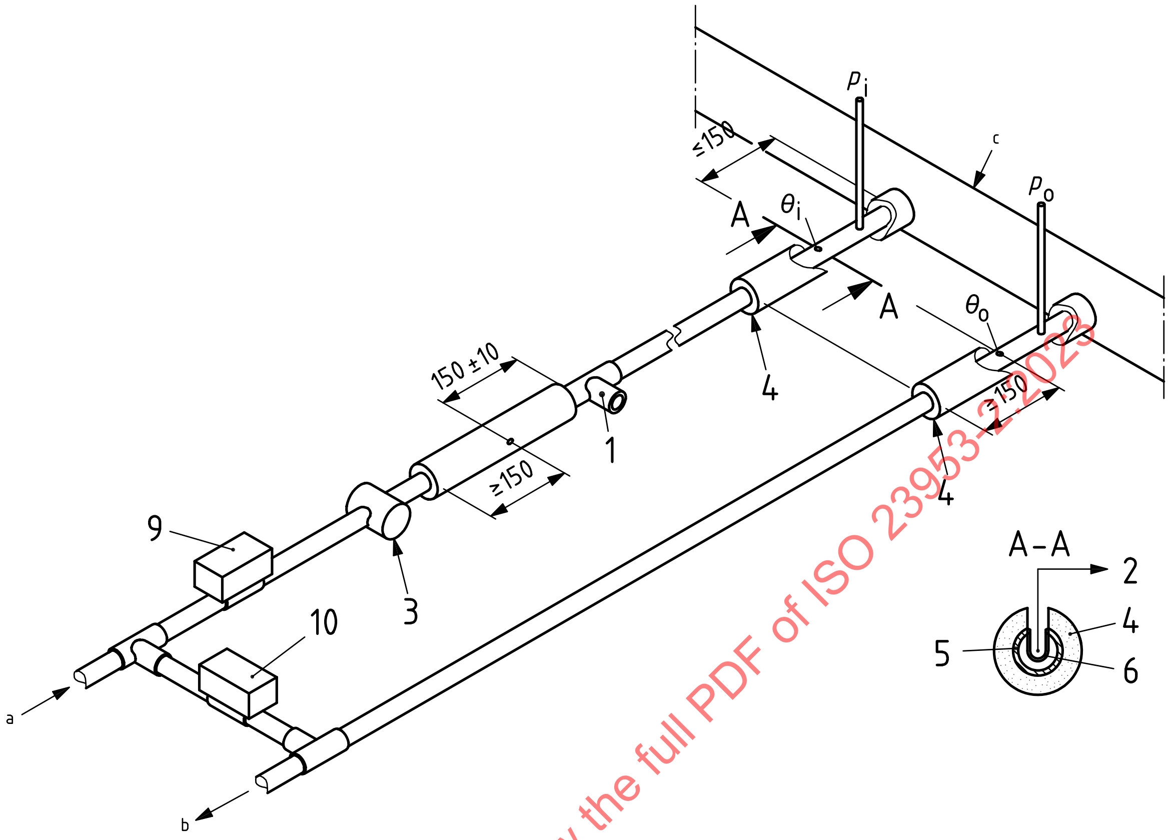
See Figure 35.

The instant heat extraction rate in kW is defined as in Formula (7):

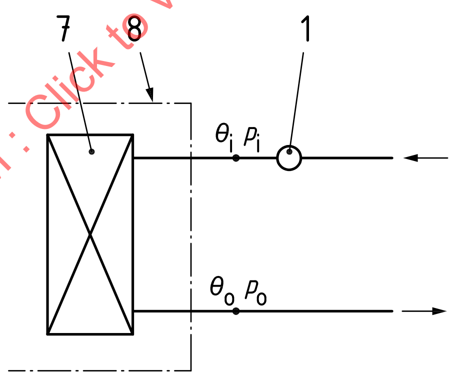
$$\Phi_n = q_m \left[(c_0 \times \theta_0) - (c_i \times \theta_i) \right] \qquad (7)$$

for each individual measuring instant, where n indicates the measuring sample (Φ_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 Cabinet wall.

Figure 35 — Cabinets intended for connection to indirect-type refrigerating systems

5.3.7.3 Method

5.3.7.3.1 General

The summation of the instant heat extraction rates Φ_n, in kW, over 24 h gives the total heat extraction, Q_{tot}, in kWh (see Figures 36 to 38) according to Formula (8):

$$Q_{tot} = \sum_{n=1}^{N_{max}} \Phi_n \times Dt \tag{8}$$

where Φ_n = 0 kW during stopping and defrost time.

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

Φ_{24} the heat extraction rate necessary for a multi-cabinet installation in laboratory conditions, in kW;

$\Phi_{24\text{-deft}}$ the heat extraction rate for calculating the energy consumption of a cabinet in laboratory conditions, in kW.

5.3.7.3.2 Determination of heat extraction rates

See Figures 36 to 38.

The heat extraction rate necessary for a single cabinet installation, Φ_{run}, shall be calculated by arithmetic averaging of the instant heat extraction rates Φ_n during the running time only (t_{run}) as defined in Formula (9):

$$\Phi_{run} = \frac{Q_{tot}}{t_{run}} = \frac{Q_{tot}}{24 - t_{deft} - t_{stop}} \tag{9}$$

The heat extraction rate necessary for a multi-cabinet installation Φ_{24} shall 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}) as defined in Formula (10):

$$\Phi_{24} = \frac{Q_{tot}}{t_{run} + t_{stop} + t_{deft}} = \frac{Q_{tot}}{24} \tag{10}$$

A heat extraction rate for calculating the energy consumption of a cabinet $\Phi_{24\text{-deft}}$ shall 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}) as defined in Formula (11):

$$\Phi_{24-deft} = \frac{Q_{tot}}{t_{run} + t_{stop}} = \frac{Q_{tot}}{24 - t_{deft}} \tag{11}$$

The $\Phi_{24-deft}$ value shall be used in the $E_{REC,24h}$ calculation formula (see 5.3.7.3.3).

5.3.7.3.3 Calculation of $E_{REC,24h}$

The refrigeration daily electrical energy consumption for a cabinet intended for a remote compression-type refrigerating system, $E_{REC\text{-}RC,24h}$, is calculated from the following Formula (12):

$$E_{REC\text{-}RC,24h} = (24 - t_{deft}) \times \Phi_{24\text{-deft}} \times \frac{(T_c - T_{mrun})}{(0{,}34 \times T_{mrun})} = Q_{tot} \times \frac{(T_c - T_{mrun})}{(0{,}34 \times T_{mrun})} \tag{12}$$

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 Formula (13):

$$T_{m\text{run}} = \theta_i - 4 \tag{13}$$

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 daily energy consumption ($E_{\text{CPEC,24h}}$), in kWh, is calculated using Formula (14); assuming a pressure drop in the system equalling 2,5 times the pressure drop over the cabinet and a pump efficiency of 0,5:

$$E_{\text{CPEC,24h}} = \sum_{n=1}^{N_{\max}} \frac{2{,}5 v q_{\text{L},n} \left(P_{i\text{run},n} - P_{o\text{run},n} \right)}{0{,}5} \Delta t \tag{14}$$

where

$P_{i\text{run},n} - P_{o\text{run},n}$ is the instant value of pressure drop between the inlet and outlet of cabinet during t_{run}, in kPa;

$q_{\text{L},n}$ is the instant value of the mass flow of liquid coolant during test period in kg/s. The maximum sampling period shall be 180 s.

The value of $E_{\text{CPEC,24h}}$ as above defined shall be added to the direct daily electrical energy consumption $E_{\text{DEC,24h}}$ (see 5.3.6.3).

The refrigeration daily electrical energy consumption for a cabinet intended for a remote indirect refrigerating system, $E_{\text{REC-RI,24h}}$, in kWh is calculated from the following Formula (15):

$$E_{\text{REC-RI,24h}} = \left[(24 - t_{\text{deft}}) \times \Phi_{\text{24-deft}} + 0{,}5\ E_{\text{CPEC,24h}} \right] \times \frac{T_c - T_{m\text{run}}}{0{,}34 \times T_{m\text{run}}} \tag{15}$$

with a constant condensing temperature of T_{c} = 308,15 K (35 °C).

NOTE For both direct and indirect systems, the calculated refrigeration daily electrical 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.

5.3.7.3.4 Calculation of E_{TEC}

The total daily electrical energy consumption expressed in kWh is calculated from the Formula (16):

$$E_{\text{TEC}} = E_{\text{DEC,24h}} + E_{\text{REC,24h}} \tag{16}$$

For cabinets fitted with incorporated air-cooled condensing unit

$$E_{\text{TEC}} = E_{\text{DEC,24h}}$$

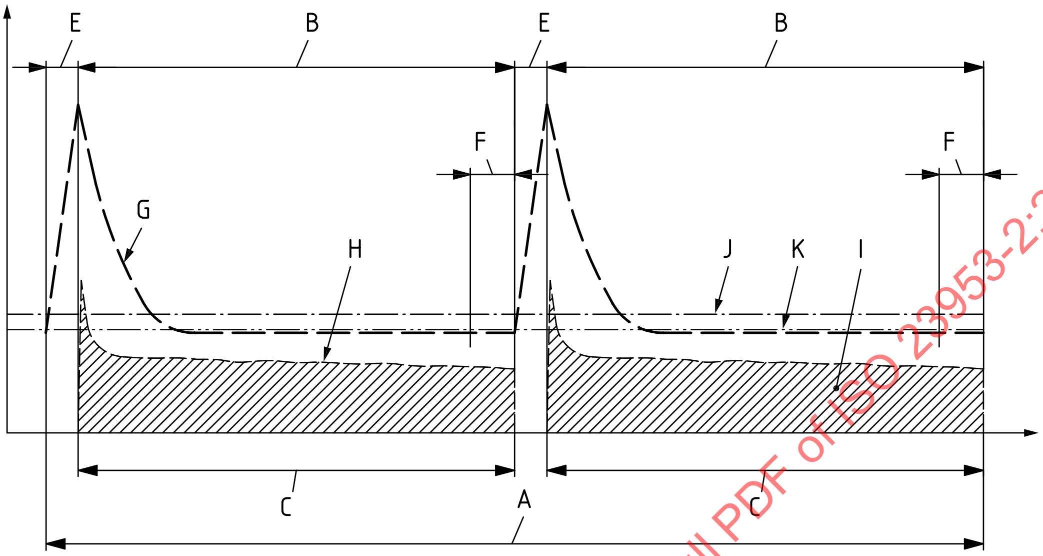
For cabinets fitted with incorporated liquid condensing unit

$$E_{\text{TEC}} = E_{\text{DEC,24h}} + E_{\text{HREC}}$$

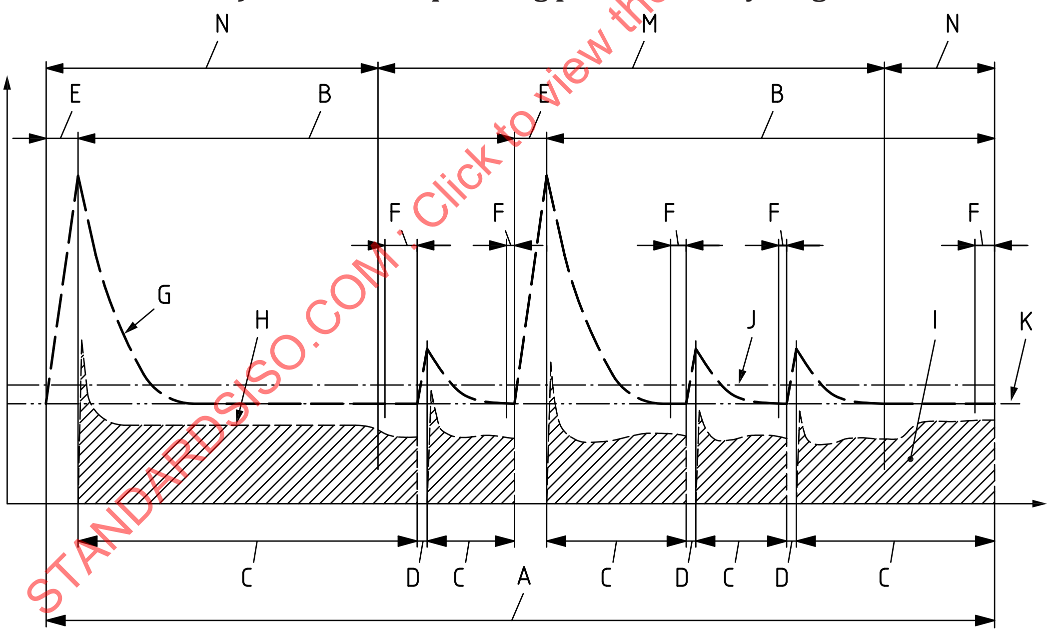
5.3.7.3.5 Calculation of E_{SEC}

The value of E_{SEC} representing the specific daily electrical energy consumption for a refrigerated display cabinet is calculated from the Formula (17):

$$E_{SEC} = E_{TEC} / S_{TDA} \tag{17}$$



a) 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})

H instant heat extraction rate (Φ_n)

I total heat extraction (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})

E defrost off period (t_{deft})

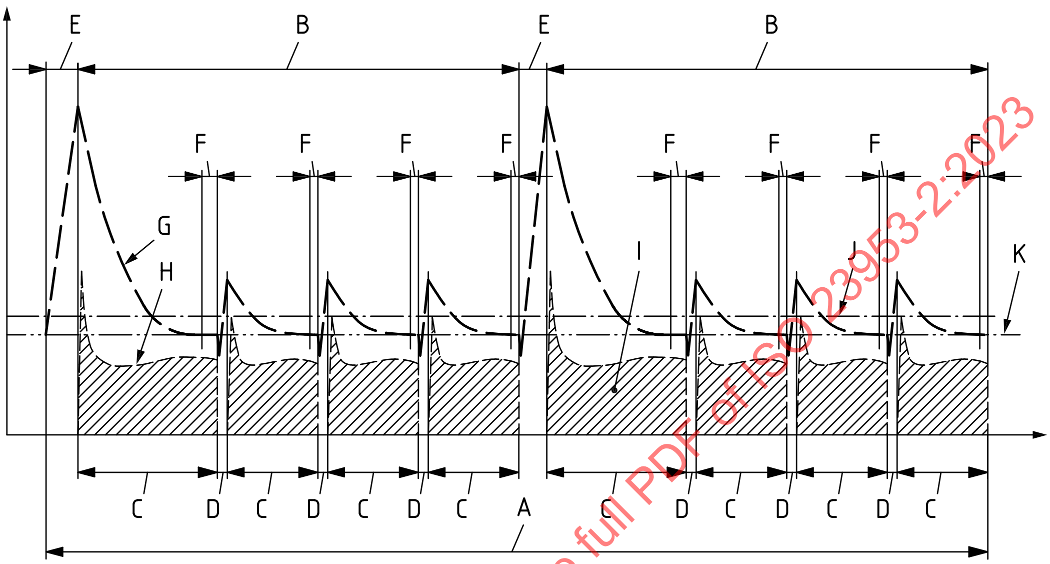
F running time for reporting minimum evaporating temperature (t_{run}·10 %)

G evaporating temperature

M night covers on 12 h

N night covers off 12 h

Figure 36 — Refrigeration cycle — Constant evaporating pressure — No cycling



Key

A 24 h (ref.)

B refrigerating period (ref.)

C running time (t_{run})

D off time (t_{stop})

E defrost off period (t_{deft})

F running time for reporting evaporating minimum temperature (t_{run}·10 %)

G evaporating temperature

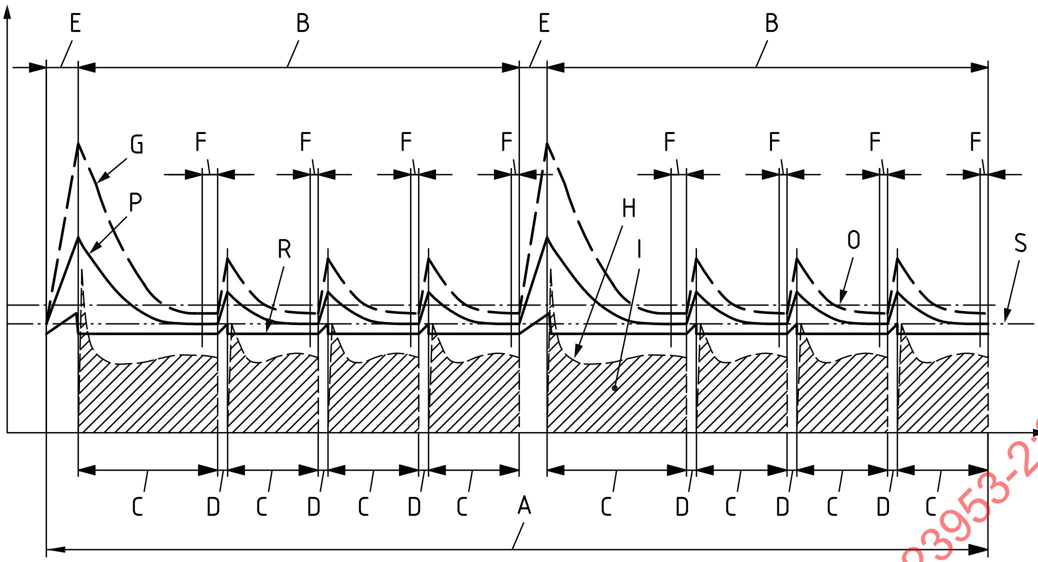
H instant heat extraction rate (Φ_n)

I total heat extraction (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})

Figure 37 — Refrigeration cycle — Cycling including pump down



Key

A 24 h (ref.)

B refrigerating period (ref.)

C running time (t_{run})

D off time (t_{stop})

E defrost off period (t_{deft})

F running time for reporting evaporating minimum temperature (t_{run}·10 %)

G secondary refrigerant outlet temperature (θ_o)

H instant heat extraction rate (Φ_n)

I total heat extraction (Q_{tot} = 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 38 — 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 5.2.2.

Test that the doors or lids seal effectively.

6.2.2 Linear dimensions, areas and volumes

According to 5.2.3.

See Table 10.

Table 10 — 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 for each temperature class according to their loading lines	S_{TDA}	m^2	2
Sneeze guard	*A*, *B*	mm	0

6.2.3 Test for absence of odour and taste

(if applicable)

See Annex C.

6.3 Tests inside test room

6.3.1 General test conditions

According to 5.3.2.

See Table 11.

Table 11 — Conditions for tests inside test room

Subclause no.	Description
5.3.2.2	Statement that the test room, test packages, filling material (wood loading), M-packages and the instrumentation used are in accordance with 5.3.2 specifying if alternative for filling test packages described in 5.3.2.7 are used.
5.3.2.4	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 12.

Table 12 — Cabinet preparation for tests inside test room

Subclause no.	Description	Symbol	Unit
5.3.3.1	The cabinet location within the test room using the Figure 8 presentation.	*X*, *B*, *Y*, *A*	mm
5.3.3.1	For cabinets intended to be placed against a wall, the location of the vertical partition at the rear of the cabinet.	d_p	mm
5.3.3.3	Number of the figure according to which the cabinet was loaded.		
5.3.3.3	Whether the cabinet was loaded as either (i) or (ii) loading of 5.3.3.2.2 or both (i) and (ii). Two sets of results shall be provided in the latter case		
5.3.3.4	The method of temperature control, defrost process, defrost termination, setting parameters and sensor locations.		
5.3.3.7	Whether the test was made with or without night-covers and/or light.		
5.3.3.6	Whether the test was made using alternative filling test packages as specify in 5.3.2.7.		

Table 12 *(continued)*

Subclause no.	Description	Symbol	Unit
5.3.3.9	When the condensing unit is remote from the cabinet for compression-type refrigerating systems the international number of the refrigerant (see ISO 817:2014).		
5.3.3.9	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 · K)
	Density.	ρ	kg/m^3

6.3.3 Temperature test

According to 5.3.4.

See Table 13.

Table 13 — Temperature test for tests inside test room

Subclause no.	Description	Symbol	Unit
5.3.4.1	For cabinets fitted with night-covers and/or lights, if the results are for the test of 5.3.3.7.1 and 5.3.3.7.2 or for both tests (two sets of results shall be provided for the latter case).		
5.3.4.1	For closed vertical cabinets state whether the results are for the (i) or (ii) loading of 5.3.3.3.2 d) or for both. Two sets of results shall be provided in the latter case.		
5.3.4.2	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 4.2.2 Table 1, 5.3.4.4 and Figure 31).	θ_{ah} θ_b θ_{al}	°C
5.3.4.5	The average mean temperatures of all M-packages (see also 5.3.4.4 and Figure 32).	Θ_m	°C
5.3.4.4	For temperature display systems, the sensor location and the maximum values displayed		
	under stable operating conditions, and		°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).		

6.3.4 Water vapour condensation test

According to 5.3.5.

See Table 14.

Table 14 — Water vapour condensation 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 test of 5.3.3.7.1 and 5.3.3.7.2 or for both tests. Two sets of results shall be provided in the latter case.		
5.3.5.1	Whether any manual switch provided for anti-condensation heaters was switched off.		
5.3.5.2	The duration of the period of observation.		h
	Coded sketches as defined in 5.3.5.3.		

6.3.5 Electrical energy consumption test

According to 5.3.6.

See Table 15.

Table 15 — Electrical energy consumption test

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 test of 5.3.3.7.1 and 5.3.3.7.2 or for both tests. Two sets of results shall be provided in the latter case.		
5.3.6.1	For closed vertical cabinets state whether the results are for the (i) or (ii) loading of 5.3.3.3.2 d) or for both. Two sets of results shall be provided in the latter case.		
5.3.6.2	For cabinets fitted with integral condensing unit:		
	direct daily electrical energy consumption (= total electrical energy consumption)	$E_{DEC,24h}$ (E_{TEC})	kWh
	compressor switching on/off frequency		
	relative running time.		
5.3.6.3	For cabinets with remote condensing unit:		
	direct daily electrical energy consumption.	$E_{DEC,24h}$	kWh

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

According to 5.3.7.

See Table 16.

Table 16 — Heat extraction rate measurement when the condensing unit is remote from the cabinet

Subclause no.	Description	Symbol	Unit
5.3.7.1.1	For cabinets fitted with night-covers and/or lights, state whether the results are for the test of 5.3.3.7.1 and 5.3.3.7.2 or for both tests. Two sets of results shall be provided in the latter case.		
5.3.7.1.1	For closed vertical cabinets state whether the results are for the (i) or (ii) loading of 5.3.3.3.2 d) or for both. Two sets of results shall be provided in the latter case.		
5.3.7.1.2 See Figures 34, 36 and 37	For compression-type refrigerating systems:		
	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
5.3.7.1.3 See Figures 35 and 38	For indirect refrigerating systems:		
	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
5.3.7.3	Heat extraction rates necessary for the cabinet which result from the foregoing measurements:	Φ_{run}	
	heat extraction rate during the running time only		kW
	heat extraction rate during a whole day, including running, stopping and defrost times	Φ_{24}	kW
	heat extraction rate during a whole day excepting defrost time	$\Phi_{24\text{-deft}}$	kW
	refrigeration electrical energy consumption over a 24 h period	$E_{REC,24h}$	kWh
	total daily electrical energy consumption	E_{TEC}	kWh
	specific daily electrical energy consumption	E_{SEC}	kWh/m^2
	for cabinets where cycling of the system is necessary for operational reasons, the percentage running time.	t_{rr}	%

7 Marking

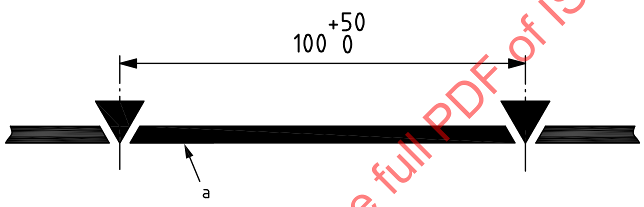
7.1 Load limit

Every cabinet shall be clearly and permanently marked with one or several load limit line(s) [see Figure 39 b)], on the inside face, as shown in Figure 41, to denote the load limit. Where it is not possible to exceed the load limit, no marking is required.

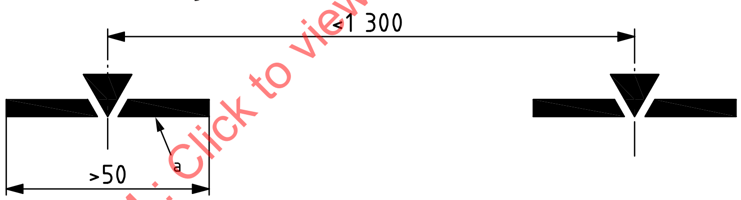
The load limit lines shall be continuous [see Figure 39 a)] or repeated at intervals [Figure 39 b)] to ensure that they cannot be overlooked. Individual markings shall be at least 50 mm long and shall contain at least one equilateral triangle with side dimension, d_l, included within 5,5 mm and 15 mm. Where load limit lines are specific to multiple temperature classifications the M-package temperature classifications shall be clearly marked on each load line in 12 mm high font [see Figure 39 c) and Figure 40 b)].

Where a load limit line cannot be marked on the inside face because of cabinet design, an outline sketch showing the load limit shall be fixed in a visible position and in the manufacturer's instruction handbook.

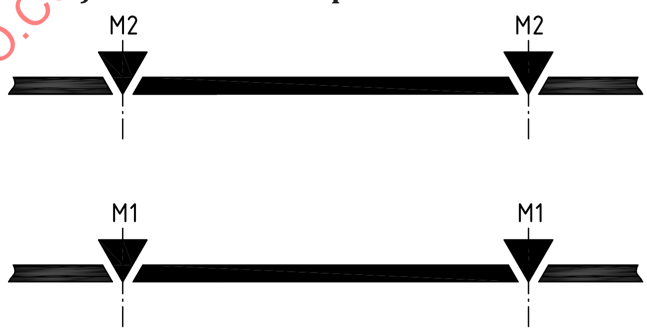
Dimensions in millimetres



a) Continuous load limit line



b) Load limit line repeated at intervals

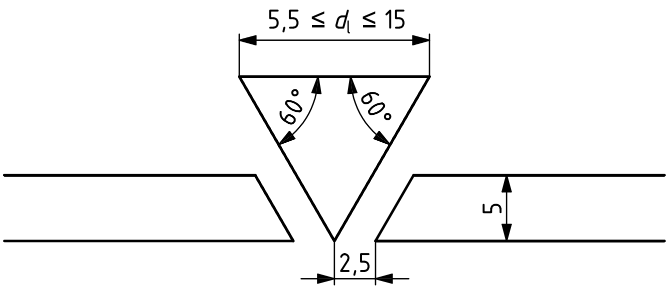


c) Multiple temperature load limit lines

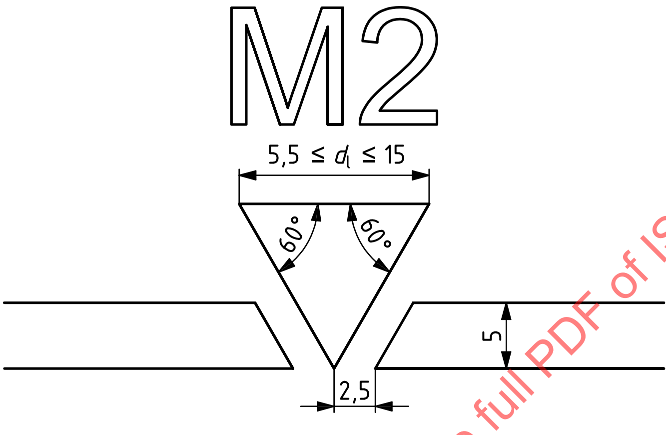
a This denotes the load limit.

Figure 39 — Load limit markings

Dimensions in millimetres

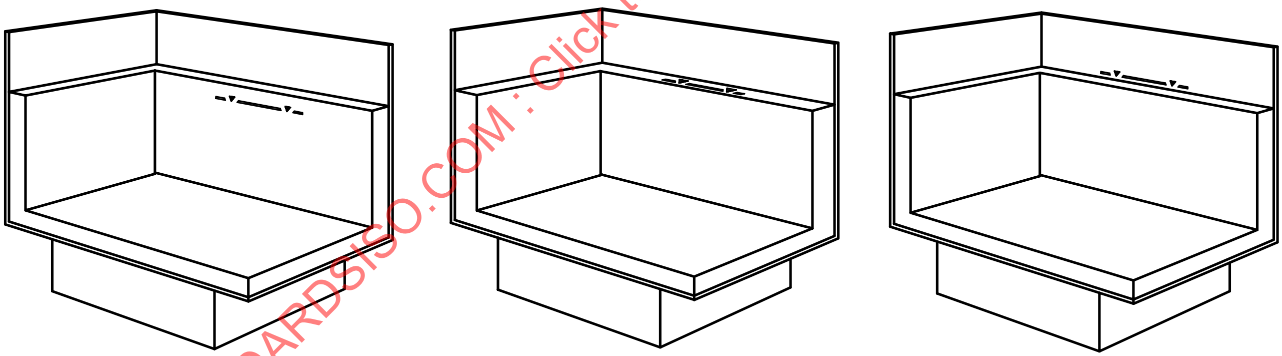


a) Dimensions of load limit line

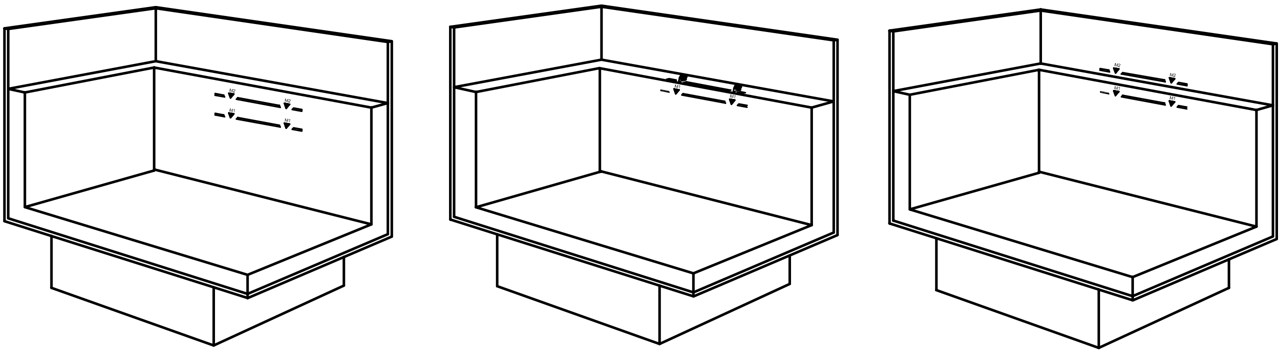


b) Dimensions of M-package temperature class marking

Figure 40 — Dimensions of load limit line and of M-package temperature class marking



a) Different positions for the load limit



b) Different positions for multiple load limit lines

Figure 41 — Example of different positions for single or multiple load limit lines

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 817:2014) used and its (their) mass;

f) for cabinets having remote condensing units, marking in accordance with ISO 5149-2:2014.

7.3 Information to be supplied by the manufacturer

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

a) Overall external dimensions at installation.

b) Overall external dimensions in service including: distance d_p between the back of the cabinet and the vertical test panel if applicable (see 5.3.3.1)

c) The intended cabinet classification/s (see ISO 23953-1:2023, 3.6.5) and for each class the following information:

1) the display opening area;

2) total display area (see Annex A);

3) where applicable, the refrigerated shelf area;

4) the maximum load, in kg, 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;

5) the direct daily electrical energy consumption ($E_{DEC,24h}$), in kWh, measured in accordance with the test described in 5.3.6;

6) the specific daily electrical energy consumption E_{SEC}; in kWh/m^2 of total display area;

7) if the condensing unit is not fitted in the refrigerated cabinet, the information referred to heat extraction rate according to 5.3.7;

NOTE For temperature and climate classes, see 4.2.2 and 5.3.2.4.1.

8) for cabinets fitted with night-covers and/or lights, if the results are for the “a)” or the “b)” test of 5.3.3.7.1 and 5.3.3.7.2 or for both tests, in the latter case with two sets of information being provided for 5), 6) and 7);

9) location of the temperature sensor;

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

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

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

Annex A
(normative)

Total display area (S_{TDA})

A.1 General

The S_{TDA} is determined by the sum of vertical and horizontal projected areas from visible foodstuff as marked by the loading line, in m^2. 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 on the shelves (see Figure A.5). If the shelves are tilted and the loading is for sensitive foodstuffs, the horizontal projected area shall be calculated applying H_o measured from a plane located at 1,55 m from the ground and its intersection with the shelf (see Figure A.6).

If the cabinet has adjustable feet, they shall be positioned in the middle of the range when measuring the geometry for the S_{TDA} calculation.

NOTE In the case the shelves are of different depth the projected area H_o is affected by the height of the cabinet when the load level line is above or below in respect of the plane located at 1,55 m from the ground as shown in Figure A.5.

For cabinets with any transparent part (rear, front, top or sides), S_{TDA} shall be calculated by the sum of vertical and horizontal projected areas from visible foodstuff from positions of the customers or service personnel. Examples of S_{TDA} calculation are given in from Figure A.1 to A.20.

A.2 Determination of S_{TDA} in a refrigerated display cabinet

The total display area shall be calculated as in Formula (A.1):

$$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times L_{gv}) \quad (A.1)$$

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;
index o	is the open;
index g	is the glazing;
index h	is the horizontal;
index v	is the vertical;
index t	is the top;
index b	is the base;
index r	is the rear;
index f	is the front;

index w is the end wall.

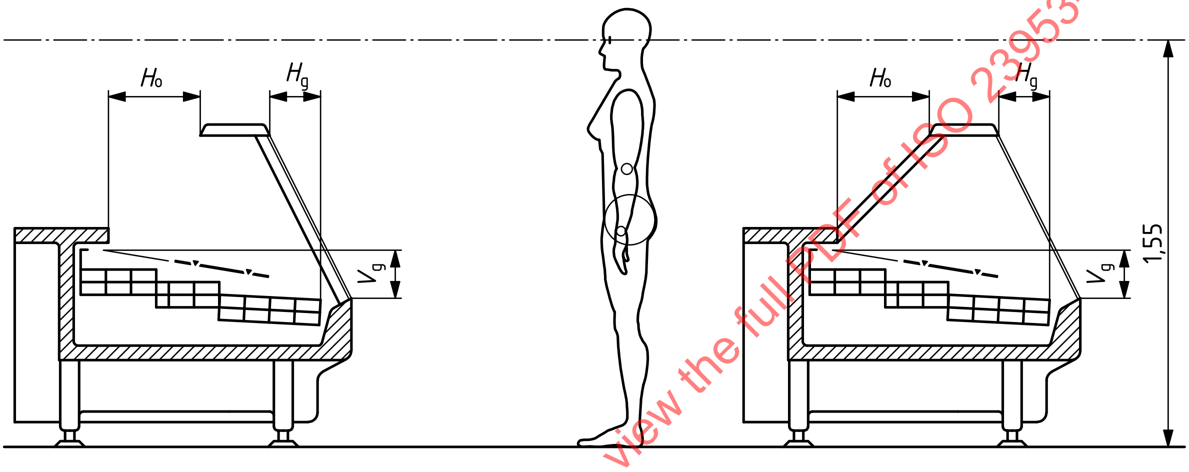
Price marking rail ticket holder area in the front of the shelf is not deducted from the S_{TDA} measurement providing that they are 60 mm or less in the vertical projection. If higher than 60 mm, the resulting area from the difference between the vertical projection and 60 mm shall be deducted from S_{TDA}.

NOTE In case of a tilted shelf it is assumed that ticket holders are positioned resulting with the same vertical projection.

Opaque areas of frames, silkscreens, handrails, handles, air guides or front risers that obstruct the view of the product shall have the projected area deducted from the measurement of the S_{TDA}.

Figures A.1 to A.20 illustrate examples of S_{TDA} calculation for the most common cabinets with a length of 2,5 m.

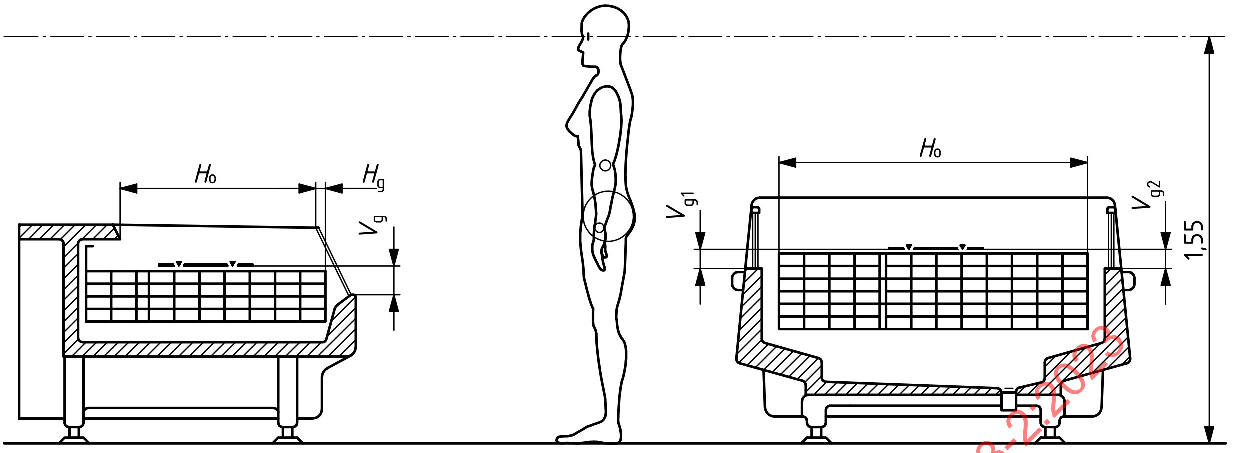
Dimensions in metres



L_{oh} = 2,500	H_o = 0,291		L_{oh} = 2,400	H_o = 0,350	
L_{gh} = 2,500	H_g = 0		L_{gh} = 2,500	H_g = 0,194	
L_{ov} = 2,500	V_o = 1,367		L_{ov} = 2,500	V_o = 0	
L_{gv} = 2,500	V_g = 0		L_{gv} = 2,500	V_g = 0,185	
$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times L_{gv})$		1,785	$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times L_{gv})$		1,788

Figure A.1 — Horizontal, serve-over counters

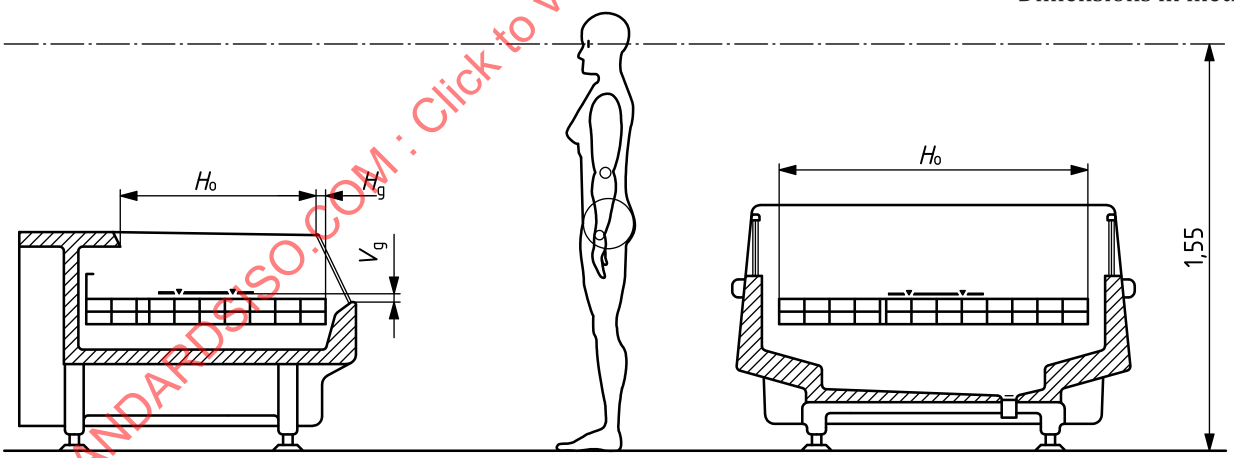
Dimensions in metres



		L_{oh} = 2,500	H_o = 1,176
L_{oh} = 2,500	H_o = 0,770	L_{gh} = 2,500	H_g = 0
L_{gh} = 2,500	H_g = 0,012	L_{ov} = 2,500	V_o = 0
L_{ov} = 2,500	V_o = 0	L_{gv1} = 2,400	V_{g1} = 0,058
L_{gv} = 2,500	V_g = 0,090	L_{gv2} = 2,400	V_{g2} = 0,058
$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times L_{gv})$	2,18	$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_{g1} \times L_{gv1}) + (V_{g2} \times L_{gv2})$	3,218

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

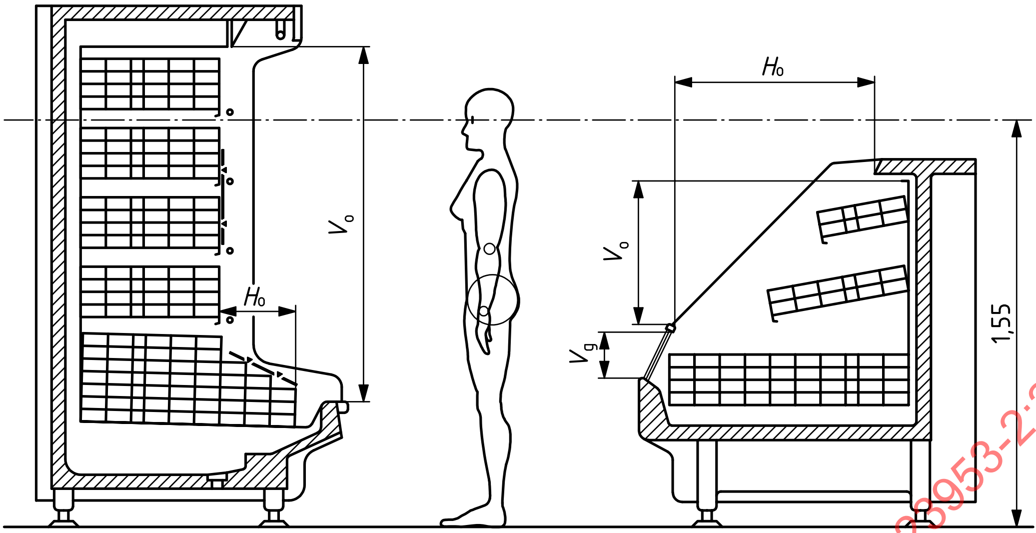
Dimensions in metres



		L_{oh} = 2,500	H_o = 1,176
L_{oh} = 2,500	H_o = 0,770	L_{gh} = 2,500	H_g = 0
L_{gh} = 2,500	H_g = 0,012	L_{ov} = 2,500	V_o = 0
L_{ov} = 2,500	V_o = 0	L_{gv1} = 2,400	V_{g1} = 0
L_{gv} = 2,500	V_g = 0,010	L_{gv2} = 2,400	V_{g2} = 0
$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times L_{gv})$	1,98	$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_{g1} \times L_{gv1}) + (V_{g2} \times L_{gv2})$	2,928

Figure A.3 — Horizontal, open, wall-site and island cabinets with sensitive foodstuff load

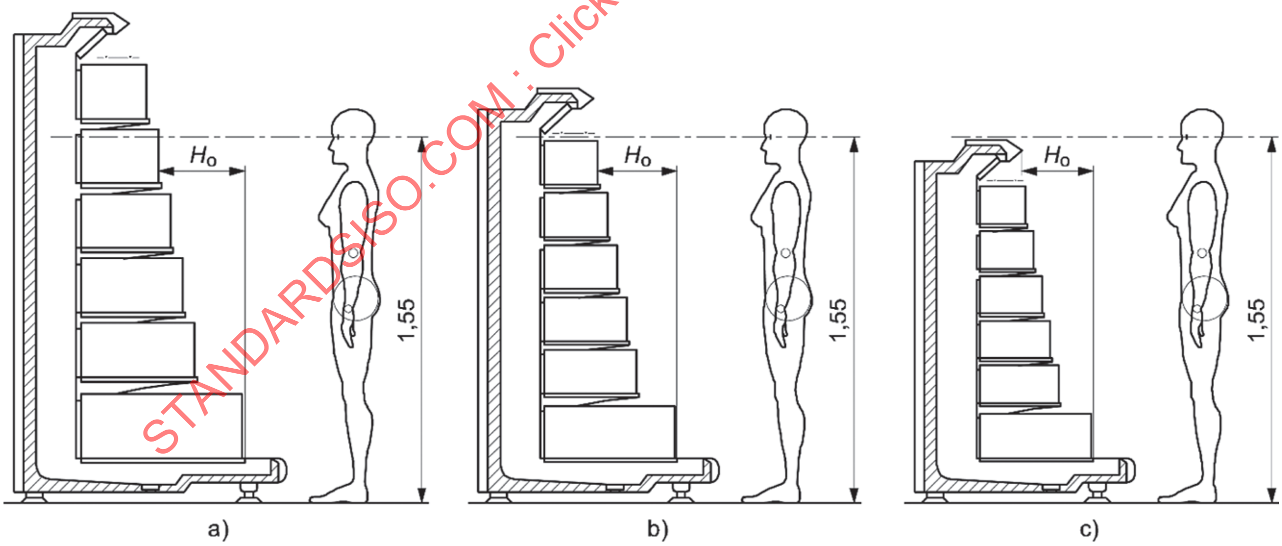
Dimensions in metres



L_{oh} = 2,500	H_o = 0,291	L_{oh} = 2,500	H_o = 0,761
L_{gh} = 2,500	H_g = 0	L_{gh} = 2,500	H_g = 0
L_{ov} = 2,500	V_o = 1,367	L_{ov} = 2,500	V_o = 0,546
L_{gv} = 2,500	V_g = 0	L_{gv} = 2,400	V_g = 0,175
$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times L_{gv})$ 4,145		$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times L_{gv})$ 3,688	

Figure A.4 — Vertical, multi-deck and semi-vertical cabinets

Dimensions in metres



vertical cabinet **vertical cabinet** **semi-vertical cabinet**

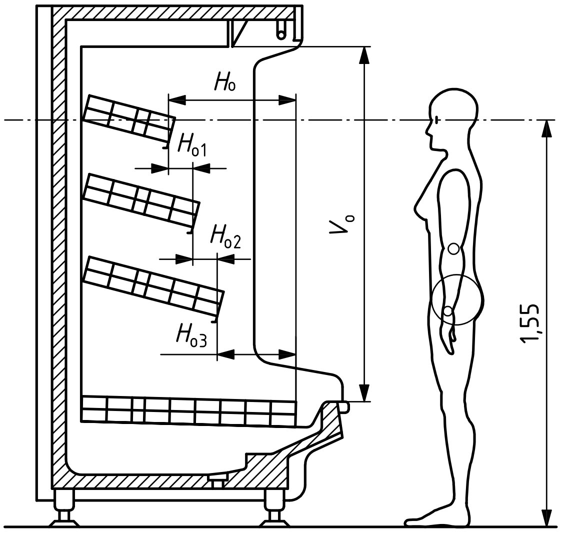
Key

H_o horizontal projected area

dashed line 1,55 m height from the ground

Figure A.5 — Example of H_o measurement for vertical and semi-vertical cabinets

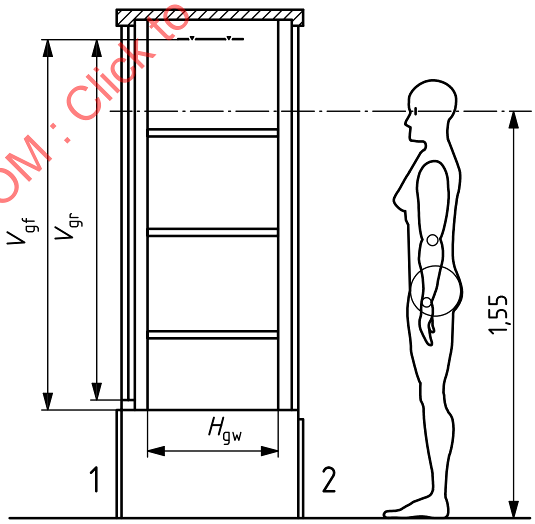
Dimensions in metres



L_{oh} = 2,500	$H_o = H_{o1} + H_{o2} + H_{o3}$ = 0,521	
L_{gh} = 2,500	H_g = 0	
L_{ov} = 2,500	V_o = 1,367	
L_{gv} = 2,500	V_g = 0	
$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times L_{gv})$		4,720

Figure A.6 — Vertical, multi-deck with tilted shelves and sensitive foodstuffs

Dimensions in metres



Key

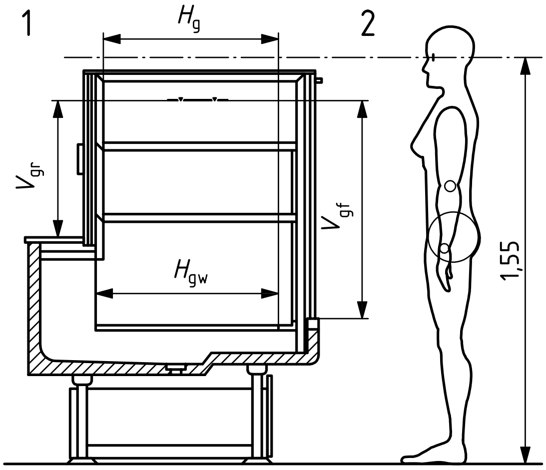
1 rear

2 front

$S_{TDA} = (V_{gr} \times L_{gvr}) + (V_{gf} \times L_{gvf}) + 2 \text{ x } (H_{gw} \times V_{gr})$

Figure A.7 — Transparent rear, front and sides cabinet

Dimensions in metres



Key

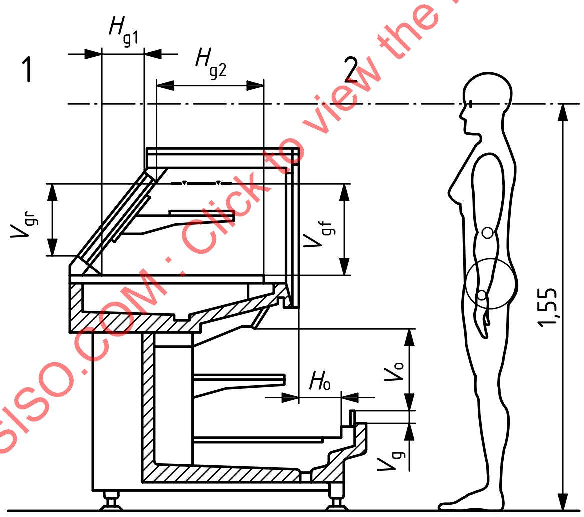
1 rear

2 front

$S_{TDA} = (V_{gr} \times L_{gvr}) + (V_{gf} \times L_{gvf}) + (H_g \times L_{ght}) + 2 \times (H_{gw} \times V_{gf})$

Figure A.8 — Transparent cabinet rear, front, sides and top

Dimensions in metres



Key

1 rear

2 front

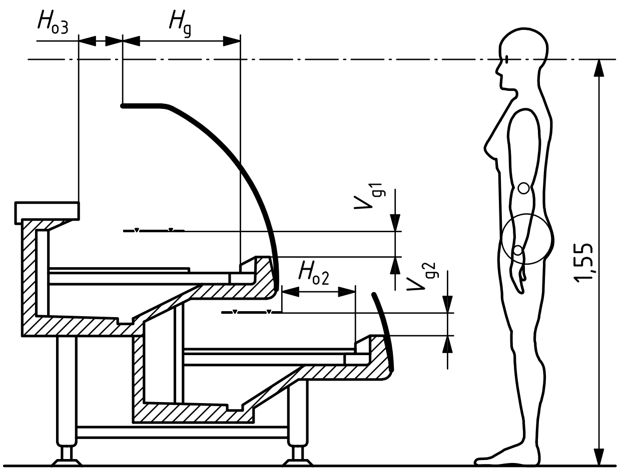
where:

$(V_o + V_g + V_{gr} + V_{gf}) \geq 0{,}45 \cdot (H_{g1} + H_{g2} + H_o)$

$S_{TDA} = (V_{gr} \times L_{gvr}) + (V_{gf} \times L_{gvf}) + (V_o + V_g) \times L_v + (H_{g1} \times L_{gh1}) + (H_{g2} \times L_{gh2})$

Figure A.9 — Semi-vertical VC1 Chilled, glass door top, open bottom

Dimensions in metres



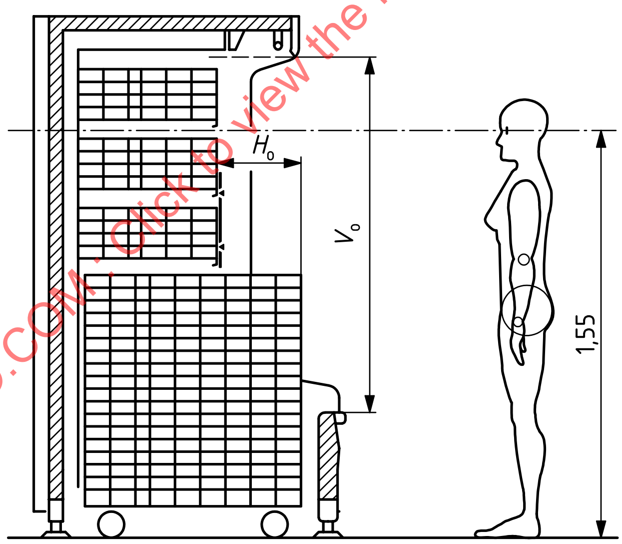
where:

$(V_{g2} + V_{g1}) \leq 0{,}45 \cdot (H_{o1} + H_g + H_{o2})$

$S_{TDA} = (V_{g2} \text{ x } L_{g2}) + (V_{g1} \text{ x } L_{g1}) + (H_{o1} \text{ x } L_{ho1}) + (H_g \text{ x } L_{hg}) + (H_{o2} \text{ x } L_{ho2})$

Figure A.10 — Horizontal refrigerated cabinet HC1 Chilled, open top, open bottom

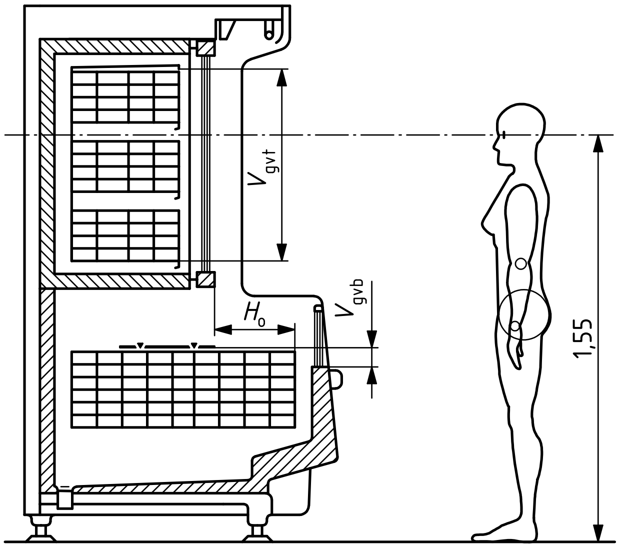
Dimensions in metres



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

Figure A.11 — Vertical, roll-in cabinet

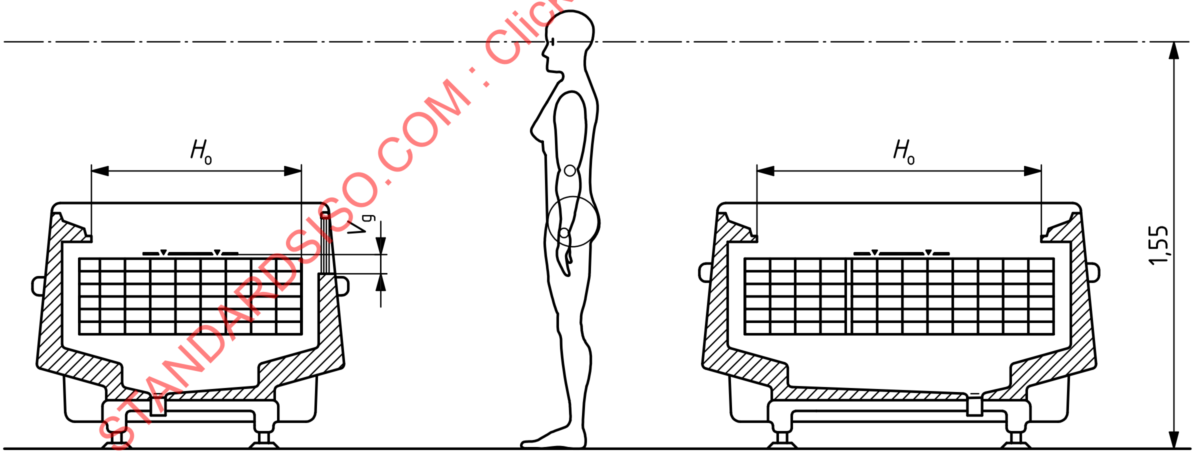
Dimensions in metres



L_{oh} = 2,500	H_o = 0,306	
L_{gh} = 2,500	H_g = 0	
L_{ov} = 2,500	V_o = 0	
L_{gvt} = 2,250	V_{gt} = 0,731	
L_{gvb} = 2,400	V_{gb} = 0,058	
$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_{gt} \times L_{gvt}) + (V_{gb} \text{ x } L_{gvb})$		2,549

Figure A.12 — Combined, glass door top, open bottom, cabinet

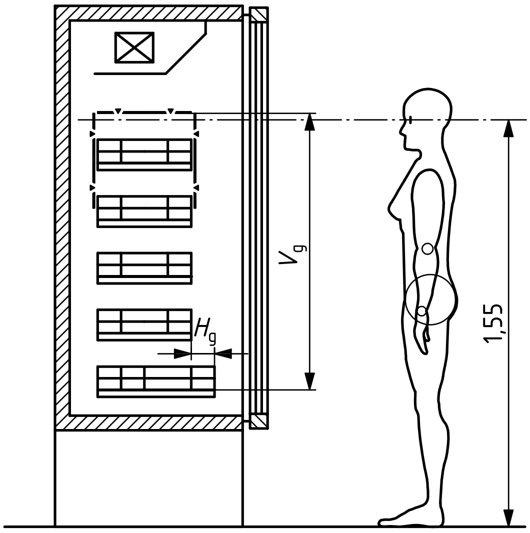
Dimensions in metres



L_{oh} = 2,500	H_o = 0,800	L_{oh} = 2,500	H_o = 1,084
L_{gh} = 2,500	H_g = 0	L_{gh} = 2,500	H_g = 0
L_{ov} = 2,500	V_o = 0	L_{ov} = 2,500	V_o = 0
L_{gv} = 2,400	V_g = 0,058	L_{gv} = 2,500	V_g = 0
$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times L_{gv})$	2,139	$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times L_{gv})$	2,710

Figure A.13 — Horizontal, open, island cabinets

Dimensions in metres



L_{oh} = 2,500	H_o = 0	
L_{gh} = 2,500	H_g = 0,25	
L_{ov} = 2,500	V_o = 0	
L_{gv} = 2,250	V_g = 1,053	
$S_{TDA} = (H_o \times L_{oh}) + (H_g \times L_{gh}) + (V_o \times L_{ov}) + (V_g \times L_{gv})$		2,994

Figure A.14 — Vertical, glass door, cabinet