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BRITISH STANDARD

BS 2501 : 1992

Specification for

Commercial refrigerated storage cabinets of the closed reach-in type

Armoires de réfrigération de type commercial, fermées, à porte ouvrante — Spécifications

Geschlossene Verkaufskühlmöbel für gewerbliche Zwecke

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Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Refrigeration, Heating and Air Conditioning Standards Policy Committee (RHE/-) to Technical Committee RHE/19, upon which the following bodies were represented:

British Gas plc
British Hotels and Restaurants and Caterers' Association
British Refrigeration Association
British Retailers' Association
Cooperative Union
Department of Health
Ice Cream Federation Ltd.
Institute of Refrigeration
Institution of Electrical Engineers
Institution of Environmental Health Officers
Institution of Grocery Distribution
London Refrigeration Society
Ministry of Agriculture, Fisheries and Food
Retail Consortium
United Kingdom Association of Frozen Food Producers

The following body was also represented in the drafting of the standard, through subcommittees and panels:

Department of the Environment (Property Services Agency)

This British Standard, having been prepared under the direction of the Refrigeration, Heating and Air Conditioning Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 1 April 1992

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Foreword

This revision of BS 2501 has been prepared under the direction of the Refrigeration, Heating and Air Conditioning Standards Policy Committee (RHE/-). It supersedes BS 2501 : 1976, which is withdrawn.

The standard is complementary to BS 2502 which deals with refrigerating equipment of larger capacity.

Reference should be made to BS 3053 for the requirements for commercial refrigerated cabinets intended for the sale and/or display of food products and to BS 4434 for the safe use of refrigerating equipment.

During the preparation of this revision the 'Montreal Protocol' was ratified. This will have an effect on the availability and handling of refrigerants in the future.

It is intended to review the requirements of the standard as refrigerant technology and alternative refrigerants are developed.

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Section 1. General

1 Scope

This British Standard specifies the construction, the methods of calculating internal volumes and shelf areas, and the method of determining performance of refrigerated storage cabinets of the closed reach-in type, for commercial use in catering and similar applications. The cabinets are intended for use in climates having dry bulb temperatures and relative humidities from 16 °C and 80 % to 40 °C and 40 %.

The approximate limits of internal temperatures intended to be covered by this standard are between −30 °C and +10 °C.

NOTE. The titles of the publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard, the definitions given in BS 5643 apply together with the following.

2.1 test room climate class

A test room climate numbered between 1 and 5 which is related to dry bulb temperature and relative humidity (see table 4).

2.2 cabinets of the closed reach-in type

Cabinets having access at the top and/or sides, fitted with lids or doors which are kept closed in normal use, and where the contents in any part of the interior may be reached without stepping into the refrigerated space.

2.3 condensing unit

The high-pressure components of a refrigerating system, including a power driven compressor, a condenser and, if required, a liquid receiver.

2.4 open-type compressor unit

A unit in which the compressor and the motor are separately mounted and mechanically linked through a belt or equivalent drive.

2.5 hermetically sealed compressor unit

A refrigerant compressor and motor assembly enclosed in a shell, rendered gas-tight by welding or other suitable means.

2.6 semi-hermetically sealed compressor unit

A refrigerant compressor and motor assembly enclosed in a shell, rendered gas-tight by bolting.

2.7 automatic defrosting

The defrosting of a cabinet or part of a cabinet where the frequency and duration of the defrost operation and removal of the defrost water from the refrigerated space do not require any action by the user.

2.8 semi-automatic defrosting

The defrosting of a cabinet or part of a cabinet when the start of each defrost operation is by action of the user, the defrost water being removed from the refrigerated space without any action by the user.

2.9 manual defrosting

The defrosting of a cabinet or part of a cabinet when the start and duration of each defrost operation is by action of the user, the defrost water, frost or ice being removed from the refrigerated space with or without any action by the user.

2.10 refrigerating system

The condensing unit, evaporator(s), valves, piping and other components through which the refrigerant circulates.

2.11 refrigerant

The medium for conveying heat in a refrigerating system. This medium is evaporated by absorbing heat at a lower temperature and liquefied by surrendering heat at a higher temperature.

2.12 high-pressure side

The portion of a refrigerating system subject to the higher or condenser pressure.

2.13 low-pressure side

The portion of a refrigerating system subject to the lower or evaporator pressure.

2.14 evaporator (cooling unit)

The portion of a refrigerating system in which liquid refrigerant is evaporated by the reception of heat.

2.15 refrigerator

A cabinet or cabinets, provided with means for being cooled, together with the associated refrigerating system which may be located within a cabinet or part of which may be remote.

2.16 door aperture size

The product of the smallest length and width (or height, as appropriate) of the opening area of the cabinet.

2.17 overall dimensions

The dimensions of the rectangular parallelepiped with vertical sides within which the cabinet, including its projecting accessories, is contained.

2.18 gross volume

The total volume of the food compartments within the inside walls of the appliance, without fittings, the doors or lids being closed, except when cooling is provided by forced air, in which case the gross volume is calculated by subtracting from the total volume the volume rendered unusable by cold-air ducting, evaporator, fan and other associated accessories.

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2.19 normal conditions of use

Those operating conditions which occur when the cabinet, including all permanently located accessories, has been set up and sited in accordance with the recommendations of the manufacturer and is in service for storage intended for commercial use in catering and similar applications.

This includes the effects of actions by non-technical personnel for the purpose of loading, unloading, cleaning, defrosting, the manipulation of accessible controls and of any removable accessories etc., according to the manufacturer's instructions, but not those resulting from interventions by technical personnel for the purposes of maintenance or repair.

2.20 net storage volume of a compartment

The part of the volume of any compartment that remains after deduction of the volume of components and of spaces recognized as unusable for the storage of food.

2.21 total storage volume

The sum of the storage volumes of all compartments, such as the fresh food storage compartment, chiller compartment and food freezing compartment.

2.22 net shelf area

The sum of the areas of the shelves, the bottoms of suspended containers and the bottom of the lining, in all refrigerated compartments.

2.23 volume of the evaporator space

The product of depth, width and height measurements of the evaporator space.

2.24 volume of fixed shelves and partitions

The product of thickness and area, the thickness of a fixed shelf or partition being the distance between the outer surfaces.

2.25 M-packages

Test packages equipped with temperature sensors.

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Section 2. Calculation of internal volumes and shelf spaces

3 Calculation of internal volumes and shelf spaces

3.1 Units of measurement

3.1.1 *Volumes*

All volumes shall be stated in metres cubed, to the nearest 0.01 m^3, for volumes up to and including 0.70 m^3, and to the nearest 0.05 m^3 for larger capacities.

3.1.2 *Areas*

All areas shall be stated in metres squared to the nearest 0.01 m^2.

3.2 Dimensions of evaporator space

The depth, width and height of the evaporator space shall be the mean horizontal and vertical dimensions of the evaporator, including baffles, fixed drip trays and other fitments if any, provided a usable gap of 100 mm or more exists between the evaporator space and the adjacent lining or shelf. Otherwise, the dimensions concerned shall be increased by the width of the gap.

3.3 Volume of the evaporator space

When calculating the volume of the evaporator space, the depth, width and height measurements shall be obtained as described in **3.2**.

3.4 Net storage volume

When calculating the net storage volume, the total volume shall be divided into convenient units of volume of geometric shape which can easily be measured. Shapes formed in the wall of the food compartment and in the door (bulges, hollows, etc.) are taken into account in calculating the gross volume, but internal fittings shall be excluded.

NOTE. When cooling is provided by fan-circulated air the volume of the space occupied by the cold-air duct, evaporator, fan and other accessories is not included in the gross volume.

Where the evaporator space contains compartments intended for use, the volumes of such compartments, computed as separate cabinets, shall be added.

The measured net storage volume shall be at least 97 % of that stated by the manufacturer.

3.5 Calculation of net shelf area

In computing the area of a shelf, the width and depth shall be the horizontal distances measured between the surfaces of the lining adjacent to the shelf, or between the surface of the lining and the farther edge of the shelf. The area of the bottom of the lining shall be the product of the inside horizontal depth and width.

Where a shelf or partition has less than 25 mm horizontal clearance at any edge, it shall be regarded as a full shelf or partition in that direction for the purpose of calculating shelf areas.

Whenever the space occupied by a removable drip tray is included in the net storage volume the part of the shelf supporting the drip tray or the bottom of the drip tray shall be considered as a food shelf area, providing that definite manual operation is needed for defrosting. When any shelf is cut away, the area of the recess shall be deducted.

3.6 Volume of fixed shelves and partitions

3.6.1 *General*

When calculating the volume of shelves or partitions, if the surfaces are corrugated or fitted with pipe grids, the outer surface shall be as defined in **3.5**. Where a shelf or partition has less than 25 mm clearance at any edge, it shall be regarded as a full shelf or partition in that direction for the purpose of calculating volumes.

3.6.2 *Refrigerated corrugated, or pipe grid shelves and partitions*

If a shelf or partition is corrugated or fitted with pipe grids the outer surface shall be defined, for the purpose of calculating volumes, as the plane joining the outer apices of the corrugations or pipes, unless the distance between adjacent corrugations or pipes is greater than 100 mm.

3.6.3 *Fractional shelves and partitions*

Where a fixed fractional shelf or partition leaves less than 25 mm clearance between any edge and the inner lining of the cabinet it shall be regarded for this purpose as a full shelf or partition in that direction.

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Section 3. Construction

4 Construction

4.1 General

4.1.1 The cabinet and its parts shall be constructed with adequate strength and rigidity for normal conditions of handling, transport and use.

4.1.2 Levelling screws shall be provided for adjusting the level of the cabinet.

NOTE. Cabinets which are constructed in sections should be so designed that all joints between the sections are rigid and airtight after erection.

4.1.3 Moving parts that would otherwise constitute an accident hazard, shall be effectively guarded when the cabinet and refrigerating systems are in operation, so that when tested in accordance with **B.9** it shall not be possible for mechanical contact to take place. All parts that require adjustment and/or periodical servicing shall be accessible.

4.1.4 Pipes and connections to moving or resiliently mounted parts shall be arranged so as not to foul or to transmit vibrations to other parts. All other pipes and connections shall be anchored, and free length shall be provided to prevent failure due to fatigue.

NOTE. Where necessary, pipes and valves should be thermally insulated.

4.1.5 Internal lamps where fitted shall be mounted in suitable fittings and provided with guards for protection against mechanical damage.

4.1.6 Internal fans shall be suitable for operation at the lowest air temperature likely to occur.

4.1.7 Cabinets shall be fitted with a suitable indicating device, which shall be visible from outside the cabinet, to show the internal cabinet air temperature.

When tested in accordance with **A.5**, the temperature value shown on test at any instant by the device shall be not greater than the corresponding highest air temperature in the warmest part of the net storage volume (see **B.5.2.1**(b) or **B.5.2.2**(b)) nor less than the corresponding lowest air temperature in the coldest part of the net storage volume (see **B.5.2.1**(c) or **B.5.2.2**(c)).

Such indicating devices shall not be fitted to:

(a) normally closed top-access cabinets having an average air temperature under test (see **B.5.2.1**(a) or **B.5.2.2**(a)) of −10 °C or colder;

(b) cabinets intended exclusively for the storage of non-perishable drinks.

4.1.8 Where interior fittings, such as sliding shelves, baskets, trays or drawers, are fitted, they shall retain their shape and ease of movement when fully loaded to the manufacturer's specifications. Where these fitments are provided with stops to prevent accidental removal, they shall be self-supporting when loaded and withdrawn to the limit of the stops.

Interior fittings and their supports shall be removable for cleaning of the fittings and supports, pan and the internal surfaces of the cabinet.

Vertical adjustment not exceeding 25 mm shall be provided for shelves, trays and pans.

NOTE. Shelves, baskets, rails, etc., and their supports should be sufficiently strong for the duty required. (See **6.2** (e).) There should be no sharp edges or corners likely to cause injury under normal conditions of use.

4.1.9 When tested in accordance with **A.5**, the temperature range of operation shall conform with the design temperature storage range.

4.2 Cabinet

4.2.1 *Materials*

Materials used in the construction of the cabinet shall be free from defects which are liable to cause undue deterioration or failure.

Under normal conditions of use, the materials used shall not shrink, warp or expand. All materials shall be resistant to attack by indigenous insects, pests and vermin; where liable to be exposed to moisture, food products or chemically active substances, they shall be resistant and shall not be toxic nor contaminate stored products placed in contact with them. Sealing materials used shall not lose any of their essential properties, such as adhesion, plasticity and moisture resistance.

NOTE. Materials should comply with British Standards where applicable.

4.2.2 *Interior and exterior finish*

Interior and exterior finishes shall be durable and capable of being cleaned effectively and hygienically. All permanent construction joints and seams within the refrigerated volume shall be sealed to prevent the entry and accumulation of potentially contaminating substances. Finishes shall not crack, chip, flake, rub off nor soften under conditions of normal service and cleaning. All metal parts and fixings used inside or on the outside, where they are liable to be exposed to moisture, shall be corrosion resistant or adequately protected against corrosion.

Where organic finishes are employed, they shall be corrosion resistant.

Electroplated metal parts used in the construction of cabinets shall be electroplated in accordance with BS 1224. For parts that are nickel plated, medium application grade shall be used. For parts that are nickel/chromium plated, service condition no.2 shall be used.

Cadmium plating shall not be used on any part within the refrigerated volume.

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4.2.3 *Doors*

Vertical cabinets shall be provided with one or more front opening insulated doors preferably of the self-closing type which are hinged and fitted with an odourless gasket, forming an air-tight seal when the door(s) are closed.

If glazed doors are provided they shall be of double or triple glazed construction and for operation below a temperature of 0 °C shall be provided with means for clearing condensation following door opening.

Glass used in glazed doors shall comply with class B of BS 6206.

Doors and external drawers where fitted shall be provided with key operated locks, with duplicate keys, to provide security of contents.

4.2.4 *Thermal insulation*

4.2.4.1 *General*

The quality, thickness and application of insulating material shall be such as to ensure that the overall coefficient of heat transfer (k) is not greater than 0.35 $W/m^2 \cdot K$ and shall prevent vapour condensation on the external surfaces when the cabinet is operated at the climate class for which it was intended.

The insulation space shall be sealed to prevent the ingress of moisture to the insulating material.

The insulation shall be vapour sealed.

NOTE. The preferred type of insulation is that which is foamed in place.

If slab-type insulation is used it shall be bonded at joints and to both external and internal linings.

Loose insulation shall not be used.

A thermal break shall be provided between the inner and outer surfaces.

4.2.4.2 *Door seals*

When tested in accordance with **A.2**, when the doors of the refrigerated volume are closed, there shall be no appreciable leakage of ambient air into the interior, either past the door gasket or by any other means.

NOTE. Where cabinets (other than cabinets with lids) have an operating temperature below 0 °C, provisions for preventing condensation and frost formation on the door seal faces should be considered.

4.2.5 *Hardware*

NOTE. The action of door fasteners, locks and hinges should be smooth and positive and designed to function properly without undue wear under normal conditions of use.

4.2.6 Drains

NOTE. Where drains, drip trays or re-evaporation receptacles are fitted they should have the capacity to cope with the requirements of operation over a period of not less then 40 h, and should be accessible for cleaning. Any condensate receptacles required to be emptied manually should have a capacity equivalent to at least 40 h of operation.

4.2.7 *Location of components*

The evaporator and associated screens, baffles, drip trays, fans and guards shall not obstruct access to stored products. Where the evaporator incorporates facilities for making ice, the ice trays shall be capable of being removed without disturbing stored products.

4.2.8 *Air circulation*

When air circulation within the refrigerated space is assisted by a fan, it shall be so placed and/or guarded as to prevent accidental mechanical contact when tested in accordance with **B.9**.

4.2.9 *Defrosting*

Where electrical resistance defrosting systems are used, the heat source(s) shall be guarded against accidental mechanical contact when tested in accordance with **B.9**. Cabinets with automatic and semi-automatic defrost shall be provided with a signal lamp to indicate when the cabinet is in a defrost cycle.

4.2.10 *Condensation*

4.2.10.1 Cabinets shall be so constructed that their electrical insulation cannot be affected by water which may condense on cold surfaces, by defrost water, by liquid which might be spilled from containers within the cabinet or compartment, or leak from hoses, couplings and other parts of the appliance.

4.2.10.2 Means shall be provided to prevent moisture dripping or splashing from baffles, drip trays or other parts onto the stored products, when tested in accordance with **B.8**.

4.2.10.3 When tested in accordance with **B.8**, there shall be no visible condensation on the outer surface of the cabinet.

4.2.10.4 When tested in accordance with **B.8**, the temperature of the surface shall at no point be less than that given in table 1.

Table 1. Minimum exterior surface temperature of the cabinet

Test room climate class	Cabinet exterior surface temperature (min.)
	°C
1	12
2	15
3	17
4	20
5	24

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4.2.11 *Mains-on power indication*

A signal lamp shall be provided to indicate that the mains supply to the cabinet is intact.

4.3 Refrigerating system

4.3.1 *Refrigerant*

The refrigerant used shall have the characteristics classified in group 1 of table 1 of BS 4434 : 1989.

NOTE. Refrigerant selection should be made with due regard to the 'Montreal Protocol' on substances that deplete the ozone layer.

4.3.2 *Overload protection*

For cabinets fitted with doors or lids the refrigerating system shall be so designed and protected that it will suffer no damage if any door or lid in the cabinet is left open while the cabinet is operating in an ambient temperature of the appropriate test room climate class. This shall be verified by running the cabinet under the appropriate climate class conditions in the unloaded condition with the door fully open for 48 h with no evidence of damage.

NOTE. When the door or lid is left open under normal operating conditions, an automatic overload protective device, if fitted, may come into operation.

4.3.3 *System pressure*

The design and construction of all parts of the refrigerating system subject to internal pressure shall take into account the maximum working pressure to which they will be subjected when the cabinet is in operation or at rest.

When tested in accordance with **A.3**, no part of the refrigerating system shall show signs of leakage or permanent distortion.

All refrigerant-carrying components shall comply with the safety requirements of BS 4434.

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Section 4. Electrical and electronic equipment

5 Electrical and electronic equipment

5.1 Electronic equipment

Electronic equipment shall comply with appendix B of BS 3456 : Part 201 : 1990.

5.2 Electric motors

5.2.1 All motors including those driving compressors, fans etc. shall be suitable for working in the conditions to which they are applied.

5.2.2 Hermetic and semi-hermetic compressor motors shall comply with BS 4434 and with **4.1** of BS 1608 : 1990.

5.2.3 Compressor external drive motors shall comply with BS 4999 and BS 5000 as appropriate.

5.2.4 Fan motors shall comply with BS 2048, BS 4999 or BS 5000 : Part 11, depending on size or type. The over current and over temperature protection of fan motors shall be by means independent of the compressor motor protection (see **3.2.10** of BS 1608 : 1990).

NOTE. Impedance protection may be acceptable for fan motors where locked rotor currents are insufficient to cause overheating.

5.2.5 The degree of protection by enclosure applicable to the motor shall be at least to the requirements of designation IP 21 of BS 4999 : Part 105.

5.3 Motor overload and electrical protection

5.3.1 All motors shall be protected by an overcurrent protective device.

5.3.2 Built-in thermal protection for hermetic and semi-hermetic motor compressors shall comply with **3.2.2.2** and **3.2.2.3** of BS 1608 : 1990.

5.3.3 Built-in thermal protection for external drive motors shall comply with BS 4999 : Part 111.

5.3.4 External overload relays shall comply with BS 4941 : Part 1.

5.4 Switching devices

5.4.1 All switching devices shall be so designed or located that they are suitable for use under normal operating conditions and are unaffected by any moisture which may be present.

5.4.2 All switching devices shall comply with the relevant British Standards, such as BS 3955 and BS 5424 : Part 1.

5.4.3 Switching devices in all motor circuits shall be capable of breaking the stalled current of the motor.

5.5 Capacitors

5.5.1 Capacitors shall comply with BS 5267.

5.5.2 Compressor motor start and run capacitors shall be either housed within an enclosure complying with BS 5420 or insulated in accordance with BS 3456 : Part 201.

5.6 Radio and television interference

During operation, electrical components and control and switching devices shall not cause interference to radio and television reception and shall comply with BS 800.

Suppressors, when fitted, shall comply with BS 613.

5.7 Supply connections

5.7.1 Cabinets which are not intended to be permanently connected to fixed wiring shall be provided with a non-detachable flexible cord which shall be not less than 2 m in length when measured from its point of entry to the cabinet to the free end of the cord.

5.7.2 Flexible cords shall comply with BS 6500.

5.7.3 For single phase the colour of the core to be connected to the earth terminal shall be green-and-yellow, the colour of the core to be connected to the live terminal shall be brown and that to be connected to the neutral terminal shall be blue.

5.7.4 The current-carrying capacity of each flexible cable and cord shall be adequate for the full load current that will pass through it in service.

5.7.5 The cross-sectional area of the conductors in flexible cables and/or cords shall be related to the current-rating of the appliance in accordance with the provisions of the IEE Wiring Regulations for Electrical Installations (latest edition)[1)].

5.7.6 Cabinets provided with non-detachable flexible cords shall have cord anchorages such that the conductors are relieved from strain, including twisting, where they are connected to the terminals, and such that the covering of cords is protected from abrasion. It shall be possible to prevent effectively strain and twisting.

NOTE. Make-shift methods, such as tying the cord into a knot or tying the ends with string, should not be used.

Cord anchorages shall be made of insulating material or be provided with an insulating lining if otherwise failure of the insulation on the cord could make accessible metal parts live. The lining shall be fixed to the cord anchorage unless it is a rubber bushing which forms part of a cord guard.

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5.7.7 Inlet openings for external cords shall be so designed that the protective covering of the cord can be introduced without risk of damage. Inlet openings for cords shall be of insulating material or be provided with bushings of insulating material which is substantially free from ageing effects under normal conditions of use.

NOTE. The openings or bushings should be so shaped as to prevent damage to the cord. Inlet bushings should be reliably fixed.

5.7.8 Cabinets intended to be permanently connected to fixed wiring shall be provided with cable entries, conduit entries, knock-outs or glands which allow connection of the appropriate type of cable or conduit.

NOTE. Attention is drawn to the requirements of the IEE Regulations for Electrical Installations.[1)]

5.7.9 Cabinets shall be provided with supply terminals in which connection is made by means of screws, nuts or equally effective devices. The screws and nuts which clamp external conductors shall not serve to fix any other component except that they may also clamp internal conductors if these are so arranged that they are unable to be displaced when fitting the supply conductors. The terminals shall allow the connection of conductors having a current carrying capacity appropriate to that of the cabinet. The terminals shall be so fixed that when the clamping means is tightened or loosened the terminal does not work loose, internal wiring is not subjected to stress, and creepage distances and clearances are not reduced below the values given in table 2.

5.7.10 Terminals shall not be accessible without the aid of a tool, even if their live parts are protected.

NOTE. Terminals should be so designed that they clamp the conductor between metal surfaces with sufficient contact pressure and without damage to the conductor.

5.7.11 The terminal intended for the connection of the live conductor shall be marked L, that intended for the connection of the neutral conductor shall be marked N, and that for the connection of the protective earth conductor shall be marked with the symbol ⏚.

5.8 Cabinet internal wiring

5.8.1 When tested in accordance with **A.4.3**, the resistance between the earth conductor and the metal parts shall not exceed 0.1 Ω, due allowance being made for the resistance of the earthing conductor of the supply flexible cord.

NOTE. The wiring methods, together with the design, arrangement and workmanship employed, should give full protection to the electrical insulation against mechanical damage and damage from oil, high or low temperatures, refrigerant, moisture or corrosive material where these could be encountered.

5.8.2 Wires shall be so spliced or joined as to be mechanically and electrically secure. Unless made with a suitable mechanical connector, joints shall be soldered, brazed or fused together and shall be covered with insulation equivalent to that of the wires.

5.8.3 Except where a suitable termination is used the ends of every conductor other than the free end of the flexible cord shall be consolidated by twisting the strands or by a suitable form of eyelet. Where mechanical connectors or terminals are used the wire or cord shall be so anchored that there is no appreciable mechanical stress on the connector or terminal.

5.8.4 Insulation damage caused by the application of heat during soldering shall be cut away and replaced by suitable insulation.

NOTE. When the end of a conductor is being soldered or secured in a connector or terminal the electrical insulation should not be removed further than is necessary to allow the conductor to enter and completely fill the terminal, socket or splicing device and to be properly soldered.

5.8.5 When tested in accordance with **A.4.2**, the insulation resistance shall be as follows:

for functional insulation, not less than 1 MΩ

for protective and reinforced insulation (including insulation with metal foil on the outer surface), not less than 10 MΩ

When tested in accordance with **A.4.1**, no breakdown or flashover of insulation shall occur.

5.8.6 NOTE. Thread-cutting (self-tapping) and space threaded (sheet metal) screws may be used to provide earth continuity, provided that it is not necessary to disturb the connection in normal use.

Where thread-cutting or space threaded screws are used, at least two screws shall be used for each connection.

5.8.7 Soldering fluxes used shall not cause corrosion.

5.8.8 Wireways shall be smooth and free from sharp edges, burrs and flash, etc. which might cause abrasion of the insulation. Openings in sheet metal through which insulated wires pass shall be either provided with bushings of insulating material or rounded with a radius of at least 1.5 mm.

5.8.9 Wiring shall be effectively prevented from coming into contact with moving parts. This shall be verified by manual means and inspection.

5.8.10 Conductors identified by the colour combination green-and-yellow shall not be connected to terminals other than earthing terminals.

5.8.11 Aluminium wires shall not be used for internal wiring.

NOTE. Windings of a motor are not considered to be internal wiring.

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5.8.12 Internal wiring and electrical connections between different parts of the cabinet shall be adequately protected or enclosed, and shall be either so rigid and so fixed, or so insulated, that in normal use creepage distances and clearances cannot be reduced below the values given in table 2 (see **5.11.1**).

This shall be checked by measurement and manual test.

5.8.13 The cross-sectional area of internal conductors shall be such that the current rating shall not exceed the values given in the IEE Wiring Regulations for Electrical Installations.

5.8.14 Insulated conductors which in normal use are subjected to a temperature rise exceeding 50 K shall have an insulation of heat-resisting material.

5.8.15 If cables insulated and/or sheathed with polyvinyl chloride (PVC) are used for the internal wiring, where this would be subjected to temperatures consistently below 0 °C, a grade of PVC suitable for low temperatures shall be used.

5.9 Protection against accessibility to live parts

5.9.1 Cabinets shall be so constructed and enclosed that there is adequate protection against accidental contact with live parts when the test finger referred to in **B.9.1** is applied. This requirement shall apply to all positions of the cabinet when it is operated as in normal use even after opening of lids and removal of parts which may be detached without the use of tools.

5.9.2 When inserting or removing lamps which are located behind a removable cover, adequate protection shall be given against contact with live parts of the lamp cap.

NOTE. This requirement does not apply to lamps if the cabinet or its lamps can be isolated from the supply by means of a plug and socket outlet or by means of an all pole switch with clear indication of the OFF position.

5.9.3 Lacquer, enamel, paper, cotton, oxide film on metal parts, beads and sealing compound shall not be used as a means of giving the required protection against accidental contact with live parts.

5.10 Provision for earthing

5.10.1 The cabinet shall be provided with a substantial terminal or other suitable means for the attachment of a protective earth conductor. This terminal or other means shall be in effective electrical contact with metal which is accessible during normal use, or when any covers or casings, removable without the use of tools, have been removed, and which is liable to become live in the case of breakdown of electrical insulation.

NOTE. If non-electrical services are connected to the cabinet it is important that they are bonded to a protective conductor at the point of entry to the cabinet.

5.10.2 The printed conductors of printed circuit boards shall not be used to provide continuity of the protective earthing circuit.

5.10.3 Earthing terminals shall not be electrically connected to the neutral terminal.

5.10.4 The earth terminal shall be so designed that the pressure necessary to clamp the conductor does not serve to secure any other component.

5.10.5 The earth terminal shall be marked ⏚.

5.10.6 The resistance shall not exceed 0.1 Ω between any metal part of the cabinet intended to be earthed and the earthing conductor of the supply flexible cord or the earthing terminal.

NOTE 1. Metal parts which are separated from live parts by earthed metal or by double insulation are not considered as likely to become live in the event of breakdown. Details are given in BS 2754.

NOTE 2. Small isolated metal parts on, or screws in or through, non-conducting material, and separated by such material from current-carrying parts in such a way that in normal usage they cannot become live, are excluded from the provisions of the above.

5.11 Creepage distances and clearances

5.11.1 When measured in accordance with appendix E of BS 3456 : Part 201 : 1990, creepage distances and clearances shall be not less than the values shown in table 2.

5.11.2 If a resonance voltage occurs at the point where a winding and a capacitor are connected together, and metal parts are separated from live parts by basic insulation only, the creepage distance and clearance shall be not less than the values specified for the voltage imposed by the resonance. The creepage distance and clearance shall be increased by 4 mm in the case of reinforced insulation.

5.11.3 Creepage distances and clearances shall also be measured with supply conductors fitted, and also without conductors.

NOTE. Supply conductors should be of the largest cross-sectional area specified in the IEE Wiring Regulations for Electrical Installations.

5.11.4 The clearances and creepage distances shall also be measured with belts in place and the devices intended for varying the belt tension adjusted to the most unfavourable position within their range of adjustment. Measurements shall also be taken with the belts removed.

5.11.5 The clearances between terminals and accessible metal parts shall also be measured with the screws or nuts unscrewed as far as possible but the clearances shall then be not less than 50 % of the values shown in table 2.

Movable parts shall be placed in the most unfavourable position; nuts, and screws with non-circular heads, shall be assumed to have been tightened in the most unfavourable position.

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Table 2. Creepage distances and clearances

Points of measurement	Distances			
	Working voltage over 130 V up to 250 V		Working voltage over 250 V up to 440 V	
	Creepage distance	Clearance	Creepage distance	Clearance
	mm	mm	mm	mm
Between live parts of different polarity (see note 2)				
if protected against deposition of dirt	2.0	2.0	2.0	2.0
if not protected against deposition of dirt	3.0	2.5	4.0	3.0
if lacquered or enamelled windings	2.0	2.0	3.0	3.0
Between live parts and other metal parts over basic insulation				
if protected against deposition of dirt (see note 3)				
if of ceramic material or pure mica, etc.	2.5 (see note 4)	2.5 (see note 4)	—	—
if of other material	3.0	2.5 (see note 4)	—	—
if not protected against deposition of dirt	4.0	3.0	—	—
if the live parts are lacquered or enamelled windings	2.0	2.0	—	—
at the end of tubular sheathed-type heating elements	1.0 (see note 6)	1.0 (see note 5)	—	—
Between parts of different polarity, including the connecting wires, of positive temperature coefficient (PTC) resistors, if protected against deposition of moisture and dirt (see note 3)	1.0	1.0	—	—
Between live parts and other metal parts over reinforced insulation				
if the live parts are lacquered or enamelled windings	6.0	6.0	—	—
for other live parts	8.0	8.0	—	—
Between metal parts separated by supplementary insulation	4.0	4.0	—	—
Between live parts in recesses in the mounting face of the appliance and the surface to which it is fitted	6.0	6.0	—	—

NOTE 1. The values given in table 1 do not apply to a component part for which creepage distances and clearances are specified in the British Standard with which the part complies nor to printed wiring circuits.
NOTE 2. The clearances specified do not apply to the air gap between the contacts of thermal controls, overload protection devices, switches of micro-gap construction, etc. nor to the air gap between the current-carrying members of such devices where the clearance varies with the movement of the contacts.
NOTE 3. In general, the interior of an appliance having a reasonably dust-proof enclosure is considered to be protected against deposition of dirt, provided that the appliance does not generate dust within itself. Hermetic sealing is not required.
NOTE 4. If the parts are rigid and located by mouldings or if the design is such that there is no likelihood of a distance being reduced by distortion or movement of the parts, this value may be reduced by 2.0.
NOTE 5. If protected against deposition of dirt.
NOTE 6. If over ceramic, pure mica, etc. that is protected against the deposition of dirt.
NOTE 7. The contribution to the creepage distance of any groove less than 1 mm wide is limited to its width.
NOTE 8. Any air gap less than 1 mm wide can be ignored in computing the total clearance.
NOTE 9. Uninsulated capillary tubes of thermostats are regarded as bare conductors.
NOTE 10. When assessing creepage distances and clearances, the effect of insulating linings of metal enclosures or covers should be taken into consideration by the testing authority.

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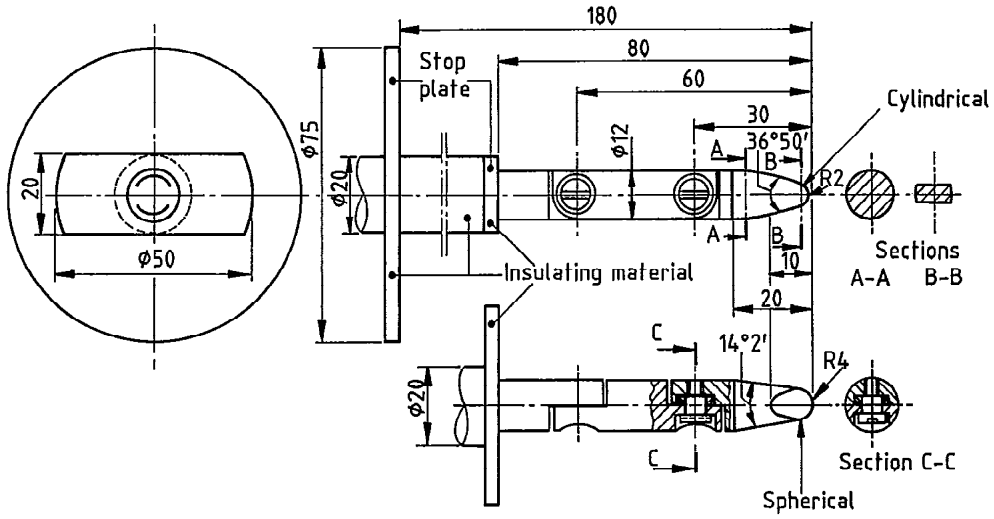
5.11.6 Distances through slots or openings in external parts of insulating material shall be measured to metal foil in contact with the accessible surface, the foil being pushed into corners by means of test fingers (see figure 1), but not pressed into openings.

5.11.7 If necessary, a force shall be applied to any point on bare conductors and to the outside of metal enclosures, in an endeavour to reduce the creepage distances and clearances while taking the measurements. The force shall be applied by means of test finger III of BS 3042 and shall have a value of 2 N for bare conductors, and 30 N for enclosures.



All linear dimensions are in millimetres

Tolerances:

on angles ±5′

on linear dimensions:

less than 25: +0, −0.05

over 25: ±0.2

Figure 1. Test fingers

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Section 5. Marking and information

6 Marking and information

6.1 Marking

6.1.1 The marking of the cabinet, which shall be generally in accordance with BS 4434, shall be the responsibility of the person, firm or company with the responsibility to ensure that the tests have been satisfactorily completed.

6.1.2 Each complete cabinet shall have at least the following information marked in a permanent legible manner in a location where it is readily accessible:

(a) the name of the person, firm or company responsible for the marking of the complete cabinet as complying with this British Standard;

(b) the number and date of this British Standard, i.e. BS 2501 : 1992[1];

(c) the type, model, catalogue and serial number of the cabinet, condensing unit, etc., or sufficient information to provide adequate identification for replacement of parts or for necessary servicing;

(d) the maximum rated input in watts, the voltage(s) or voltage range(s) and, in the case of alternating current, the rated frequency or frequency range in Hertz for which the cabinet is designed;

(e) the international number (see BS 4580) of the cabinet used;

(f) the mass of the operating refrigerant charge used (in kg), in the case of integral refrigerating systems;

(g) the range of average internal air temperature and climate class for which the cabinet has been designed and tested.

6.2 Information

The following information shall be provided by the person, firm or company responsible for supplying the cabinet but not necessarily as permanent marking:

(a) complete instructions for installation and use, including those dealing with hygiene and maintenance of performance;

(b) gross volume and net storage volume and total net shelf area;

in stating the total net shelf area, the manufacturer shall state the minimum vertical clearance above each shelf and the number of shelves supplied;

(c) in instances where the condensing unit, compressor or condenser is to be installed remote from the cabinet, the cabinet manufacturer shall state the following:

(1) the international number(s) (see BS 4580) of the refrigerants which may be used;

(2) for each refrigerant, the design operating suction pressure at the cabinet outlet, when operating in an ambient temperature appropriate to the climate class;

(3) for each refrigerant, the design operating liquid temperature at the cabinet inlet, when operating in an ambient temperature appropriate to the climate class;

(4) the required heat extraction rate, when operating in an ambient temperature appropriate to the climate class.

NOTE. For requirements regarding the specification of refrigerant condensing units, reference should be made to BS 1608 : 1990.

(d) the energy consumption, expressed in kilowatt-hours per 24 h, measured in accordance with the test described in BS 6148 : Part 6.

(e) the maximum load permitted on the trays and shelves and in the baskets for the various methods of arranging them in the cabinet.

[1] Marking BS 2501 : 1992 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

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Appendices

Appendix A. Production tests

A.1 General

The production tests given in **A.2** to **A.5** shall be applied to all cabinets in normal production.

A.2 Test for the airtightness of door or lid seal(s)

A.2.1 *Apparatus*

A.2.1.1 *Strip of paper*, 50 mm wide, 0.08 mm thick and of suitable length.

A.2.2 *Procedure*

The ambient temperature shall be between +16 °C and +32 °C, with the appliance in equilibrium with the ambient temperature. Switch the appliance off before carrying out the test.

Insert the strip of paper (see **A.2.1.1**) at any point of the seal, and close the door or lid normally on it.

Assess the seal by checking that the strip of paper does not slide freely.

NOTE. The most unfavourable points may be found by inspecting the area round the seal with the appliance closed and illuminated from the inside.

A.2.3 *Test report*

The test report shall state whether or not any appreciable leakage of ambient air occurs.

A.3 Pressure test

A.3.1 *Procedure*

A.3.1.1 Test all parts of the refrigerating system to pressures not less than indicated in table 3 (see also BS 4434) for a period of not less than 2 min.

Table 3. System test pressures

Refrigerant	High-pressure side	Low-pressure side
	bar[1)]	bar
R 22	31	17.5
R 12	19	10.5
R 115	25.5	15.5
R 502	32.5	19.5

For refrigerants other than those listed in table 3, the test pressures shall be as follows:

High-pressure side. The saturation vapour pressure of the refrigerant at a temperature of 74 °C.

Low-pressure side. The saturation vapour pressure of the refrigerant at a temperature of 49 °C.

A.3.1.2 Test the completed installation for leak tightness after it has been fully charged with the appropriate refrigerant.

A.3.2 *Test report*

The test report shall state whether or not any leakage or permanent distortion occurs.

A.4 Electrical tests

A.4.1 *Tests for high voltage*

A.4.1.1 *Apparatus*

A transformer, which is capable of maintaining a voltage of 1000 V with a current of 50 mA flowing.

A.4.1.2 *Procedure*

Subject the insulation for 1 min to an a.c. voltage of substantially sine-wave form, with a frequency of 50 Hz from the transformer (see **A.4.1.1**).

Apply the test voltage for not less than 5 s between all electric circuits and all accessible metal parts (electrically connected together for the test). Remove lamps with bayonet caps and remove or disconnect pilot lamps across mains supply leads.

Initially apply not more than half the voltage, then raise it rapidly to 1000 V.

A.4.1.3 *Test report*

The test report shall state whether or not any flashover or breakdown occurs during the test.

A.4.2 *Test for insulation resistance*

A.4.2.1 *Procedure*

Immediately after the high-voltage test (see **A.4.1**) measure the insulation resistance at 500 V d.c., the test voltage being obtained from an independent source or generated in the measuring instrument. Make the test between the following parts.

(a) Between live parts and the following parts connected together:

(1) accessible metal parts;

(2) metal foil on external parts of insulating material;

(3) metal shafts of handles, knobs and grips if these handles, etc. can be removed without the use of tools.

(b) Between live parts of different polarity as far as the necessary disconnections can be made without damaging the cabinet or its parts.

(c) Between metal enclosures or metal covers lined with insulating material and metal foil on the inner surface of the lining, if the clearance between live parts and these metal enclosures or covers, without the lining, is less than required in clause **14** of BS 3053 : 1983.

A.4.2.2 *Test report*

The test report shall state the measurements obtained of insulation resistance.

[1)] 1 bar = 10^5 N/m^2 = 100 kPa.

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A.4.3 ***Test for earth continuity***

A.4.3.1 *Procedure*

Pass a current of 25 A between the earthing terminals or the free end of the earthing conductor of the supply flexible cord, if provided, and all exposed metal parts. The test shall be made in a circuit, the voltage of which does not exceed 12 V.

A.4.3.2 *Test report*

The test report shall state the resistance between the earth conductor and the metal parts.

A.5 Temperature test

A.5.1 ***Apparatus***

A.5.1.1 *Calibrated temperature recorder*, or data logging device.

A.5.2 ***Procedure***

A.5.2.1 Place the temperature-sensing phial in the most unfavourable temperature position for the cabinet with the cabinet set to operate at the designed condition.

The door(s) shall remain closed during the test.

A.5.2.2 Maintain the test for a minimum of 10 cycles to demonstrate that the design storage temperature is achieved and maintained. Include at least one defrost cycle where applicable.

A.5.2.3 Do not allow the cabinet to defrost during the period of cooling to the temperature range of operation.

A.5.2.4 Carry out the test at an ambient temperature between +16 °C and +32 °C.

A.5.2.5 Retain a record of the test for a minimum of 3 years.

A.5.3 ***Test report***

The test report shall state whether or not the temperature range of operation conforms with the design temperature storage range.

Appendix B. Type tests

B.1 Selection and preparation for type tests

B.1.1 Each specimen commercial refrigerated cabinet to be tested shall, if not a prototype, be selected from stock or routine factory production and shall be representative as to construction and adjustment.

B.1.2 The test report shall clearly state whether the cabinet tested is a prototype or a cabinet taken from stock or factory production.

B.1.3 Assemble the cabinet, including all components, as required for normal operation, set up and sited as it would be installed in service. This shall be done as nearly as practicable in accordance with the intentions of the manufacturer so far as these are stated or known.

All permanently located accessories required for normal use shall be in their respective places.

When the condensing unit is remote from the cabinet, the cabinet manufacturer shall state for the specified test conditions the following:

(a) the international number (see BS 4580) of the refrigerant;

(b) the design operating suction pressure at the cabinet outlet, when operating in an ambient temperature appropriate to the climate class;

(c) the design operating liquid temperature at the cabinet inlet, when operating in an ambient temperature appropriate to the climate class;

(d) the heat extraction rate, when operating in an ambient temperature appropriate to the climate class. (Some measuring methods are described in BS 1586).

B.1.4 Switch the cabinet on and allow it to run for at least 24 h (or at least 2 h in the case of cabinets intended to be switched off at night) before the test is started at the specified climate class, with no packages in the cabinet.

B.1.5 When cabinets with remote condensing units are being tested, the operating conditions shall comply with those stated by the cabinet manufacturer.

B.1.6 During the running-in period in accordance with **B.1.4** and **B.1.5**, there shall be no erratic functioning of the refrigerating system, controls or defrosting operations.

B.1.7 Fill the cabinet up to the load limit by making use primarily of packages of size 200 mm × 100 mm × 50 mm, then of 100 mm × 100 mm × 50 mm and then of 100 mm × 50 mm × 25 mm (see **B.4.2**), previously brought to a temperature approximately equal to the average mean temperature expected during the test. Place the packages with temperature sensors in the positions specified for each test to be made (see **B.4.3.1**).

B.1.8 Set any automatic control according to the manufacturer's instructions.

B.1.9 Follow the normal routine of defrosting.

B.2 Test conditions

B.2.1 ***Positioning of cabinets***

Cabinets intended to be placed against a wall shall be positioned with the back at a distance from the wall as recommended by the manufacturer or, if no such distance is recommended, at a distance of 100 mm.

B.2.2 ***Remote condensing systems***

During the test of cabinets having remote condensing systems, the actual operating liquid temperature taken at the cabinet inlet shall be not more than 10 K above the specified test room temperature. No 'flash gas' condition shall occur at the inlet to the cabinet during the type test.

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B.2.3 ***Test room***

If more than one cabinet is being tested in the same room, ensure that the conditions surrounding each cabinet are in accordance with **B.2.5** to **B.2.9** using partitions or other appropriate method if necessary.

B.2.4 ***Power supply***

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

B.2.5 ***Air movement***

Local air movement shall be provided, such that with the cabinet(s) switched off, the air velocity at any point along the line shown in figure 2 shall be 0.2 ± 0.1 m/s.

The direction of air flow shall be such that the air enters the cabinet when at least half the door(s) or lid(s) is (are) open.

B.2.6 ***Temperature gradient***

Measure the temperature gradient before the cabinet for test is put into operation. The test room temperature may vary from floor to ceiling but the vertical temperature gradient shall not exceed 2 °C/m and there shall not be a difference of more than 6 K between the temperature measured at the floor and at the ceiling.

B.2.7 ***Climate-measuring point***

The points of measurement for ambient temperature and relative humidity shall be at points 1.0 m from the floor and 300 mm from the sides and front of the cabinet.

The points of measurement for cabinets having an integral condensing unit shall be on the opposite side to the location of the unit.

Temperatures at the measuring points and at the same height all round the cabinet shall be not lower than the temperature corresponding to the climate class of the test room (see table 4).

Table 4. Climate classes

Test room climate class	Dry-bulb temperature	Relative humidity
	°C	%
1	16	80
2	22	65
3	25	60
4	30	55
5	40	40

B.2.8 ***Test room standard climates***

Tests shall be carried out in one of the climates indicated in table 4.

B.2.9 ***Tolerance of climate classes***

The test room shall be capable of maintaining values of temperature and humidity within ± 1 K of the temperature and ± 5 % of the relative humidity at the specified measuring points.

B.3 Instruments and measuring equipment

B.3.1 All measurements shall be carried out with instruments that have been calibrated before each measurement or series of measurements.

B.3.2 Temperature measurements shall be made to an accuracy of ± 0.5 K. Air temperatures shall be measured by sensors, which are protected from radiation by insertion in metal shields with high reflective surfaces, each having a thermal mass equivalent to 25 g of copper, for example a copper cylinder having a mass of 25 g and a minimum external area. Temperatures shall be registered on recording instruments.

B.3.3 Pressure shall be measured to an accuracy of ± 2 %.

B.3.4 Relative humidity shall be measured to an accuracy of ± 3 % and registered on a recording instrument.

B.3.5 Energy consumption shall be measured to an accuracy of ± 2 %.

B.3.6 Time interval measurement shall be made to an accuracy of ± 1 % or better and it shall be possible to provide readings of 60 s or less.

B.3.7 Air velocity shall be measured and a sufficient number of readings shall be taken to ensure that the average air velocity is within the limits stated in **B.2.5**.

B.4 Determination of temperature

B.4.1 ***Cabinet air temperature measurement***

Measure the cabinet air temperature at a sufficient number of positions (not less than four) so that the average of these measurements is a true representation of the average temperature in the net storage volume.

Support all temperature-measuring elements in the cabinet in such a manner that there will be at least 13 mm of air space separating the thermal element from contact with heat-conducting surfaces in the cabinet. Bring connections from the temperature-measuring elements to the outside of the cabinet in such a manner as to interfere as little as possible with air seals.

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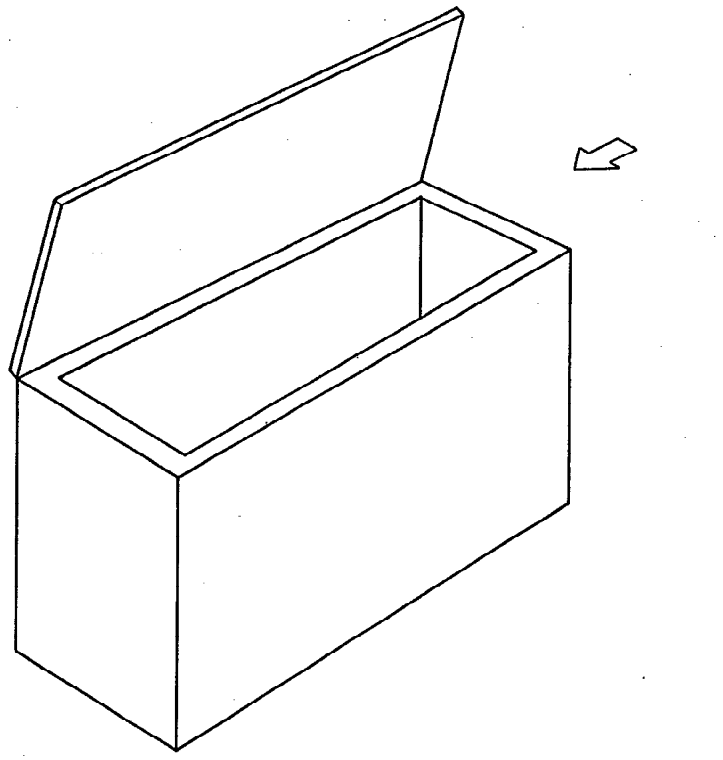

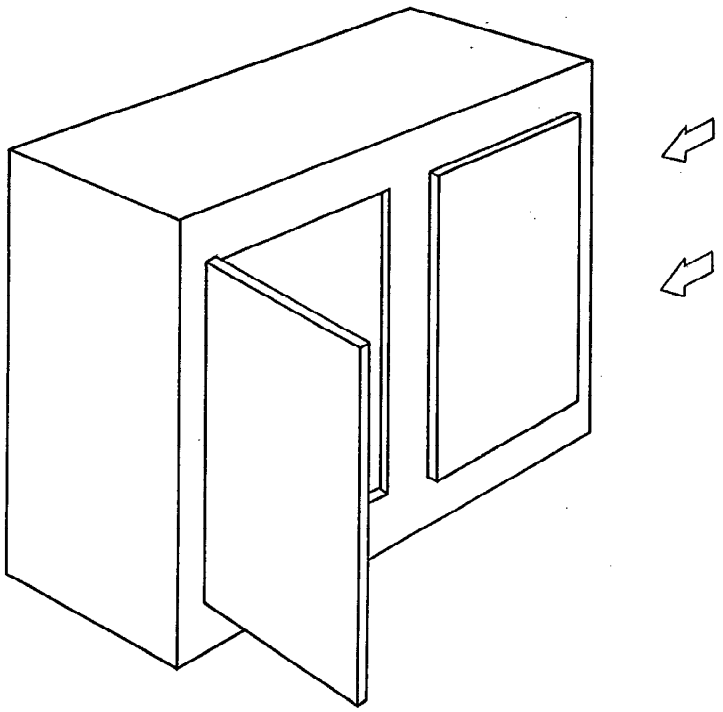

Figure 2. Air movement

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B.4.2 ***Test packages***

B.4.2.1 Test packages shall be parallelepipeds of the dimensions and masses shown in table 5.

Table 5. Sizes and masses of test packages

Dimensions	Mass
mm	g
50 × 100 × 200	1000
50 × 100 × 100	500
25 × 50 × 100	125

Tolerances shall be ± 3 % on all linear dimensions and ± 2 % on the mass.

The filling substance shall be composed as follows, per 1000 g:

oxy-ethyl-methyl cellulose	230 g
water	764.2 g
sodium chloride	5 g
parachloromctacrcsol	0.8 g

NOTE. Other filler materials may be used provided that they have the same thermal characteristics as oxy-ethyl-methyl-cellulose.

The filling substance shall be packed into a plastics wrapper or other suitable material of such quality that exchanges of moisture with the ambient medium are negligible. After filling, the wrapping sheet shall be sealed by heat.

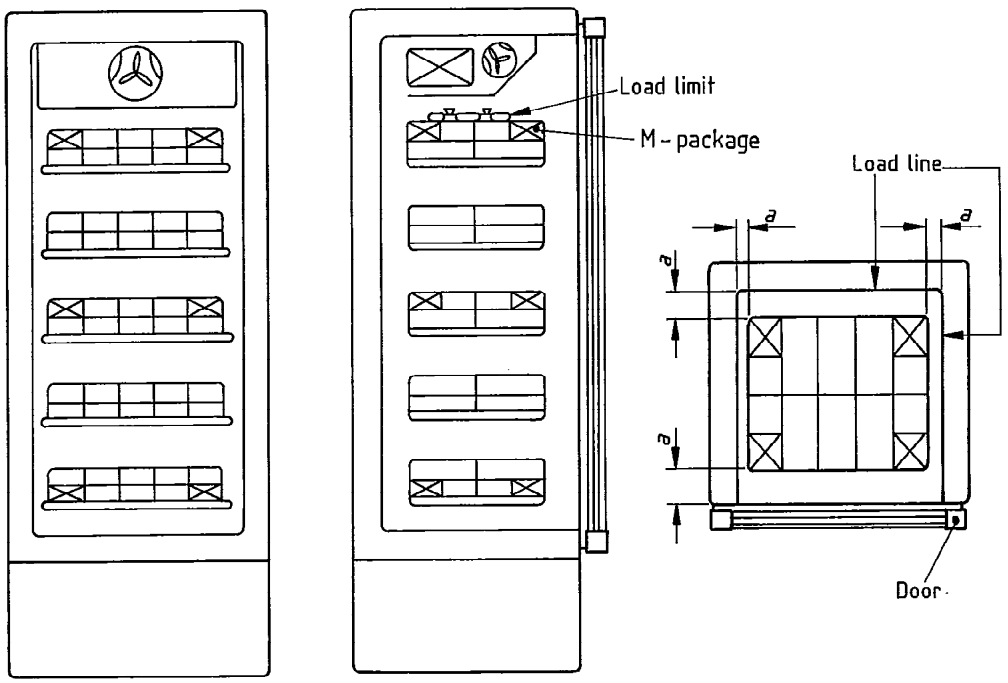
The surface emissivity shall be equal to 0.9 ± 0.05 at a temperature of 25 °C.

B.4.2.2 Some packages of dimensions 50 mm × 100 mm × 100 mm shall be equipped for temperature measurements, with temperature sensors placed in the geometrical centre of each package and with the connecting leads parallel to the long sides of the packages. Such packages, termed M-packages, may be constructed from two packages of 25 mm × 100 mm × 100 mm, or four packages of 25 mm × 50 mm × 100 mm, taped together, with thermocouples arranged between the adjacent surfaces provided the sensing element is in good thermal contact with both packages.

B.4.3 ***Temperature of contents***

B.4.3.1 *Loading the cabinet*

Fill the cabinet up to the net storage volume as specified in **6.2**(b) with test packages that have been precooled in accordance with **B.1.7**. On each surface intended for the storage of products, locate M-packages, with the largest surface area



15 mm ≤ a ≤ 40 mm

Figure 3. Loading of cabinet

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horizontal, as indicated in figure 3, in two cross sections, one with the centre line of the M-package within 150 mm of the centre of the cabinet and one with the centre line of the M-package within 150 mm of one end (the end nearest to the compressor compartment if relevant). If the horizontal or vertical distance between centre lines of two M-packages in the same cross section exceeds 600 mm, place an additional M-package halfway between these.

In addition to these M-packages, locate two extra M-packages within the useful net volume so that the maximum and minimum test package temperatures will be recorded.

B.4.3.2 *Running in*

Switch the cabinet on and run in to stable conditions. Maintain the test room at the desired climate class while the temperatures of the M-packages are recorded.

NOTE 1. These recordings will vary cyclically and the length of the cycle is dependent on the time between successive defrost periods.

NOTE 2. Stable operating conditions are deemed to be reached when the temperatures at corresponding points on the temperature curve agree within ± 0.5 °C during a period of about 24 h, and when there is no trend away from the mean temperature.

For cabinets intended to be switched off at night, it is recognized that stable conditions may not be reached. The running-in period shall therefore be at least 2 h.

Open doors or lids on closed cabinets through an angle of 90° or fully opened in the case of sliding doors or lids, and then close them again, once every 6 min for 8 consecutive hours. This applies to cabinets intended to be switched off at night.

The method of opening and closing doors or lids shall be as follows.

(a) For cabinets with a single door or lid, open the door or lid to an angle of 90° for 10 s.

(b) For cabinets with two or more doors or lids, open all the doors or lids opening one way (for example to the left) together to an angle of 90° for 10 s, at the start of the test and subsequently at intervals of 12 min, 24 min, and 36 min, etc. Open all the doors or lids opening the other way (for example to the right) together to an angle of 90° for 10 s at intervals of approximately 6 min, 18 min, 30 min and 42 min and so on.

B.4.3.3 *Test period*

After the running-in period, record the temperatures of all M-packages for a period beginning and ending at corresponding points on the time/temperature cycle.

This period of time after running-in is called the test period and shall have a duration as follows:

(a) not less than 8 h for cabinets intended to be switched off at night;

(b) not less than 24 h for all other cabinets.

For all condensing units which are installed remote from the cabinet and for those applications in which the cabinet manufacturers specify a suitable condensing unit, make sufficient measurements during the test period, to establish that the actual heat extraction rate conforms to that stated by the cabinet manufacturers for the operating conditions specified.

B.4.3.4 *Plotting temperature curves of M-packages*

From the recorded temperatures of all M-packages on each shelf and in each storage area, prepare the following curves as a function of time:

(a) the temperature of the warmest M-packages;

(b) the temperature of the coldest M-packages;

(c) the arithmetical mean temperature of all the M-packages which have at least one surface visible from any position.

In the case of multiple temperature cabinets, prepare curves (a), (b) and (c) for each separate temperature zone.

When plotting the curve of the arithmetical mean temperatures, establish one point when the warmest M-package is at a peak temperature, and enough other points to ensure an accurate mean temperature/time curve. In any case plot mean temperature with a frequency of not less than four readings per hour.

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

B.4.3.5 *Calculation of average mean temperature*

For curve (c), calculate the average mean temperature θ_m, as a function of time, for the test period T so that:

$$\theta_m = \frac{1}{T}\int_O^T \theta dt$$

B.4.3.6 *Test report*

The test report for each test shall include:

(a) a statement of each test room climate for which the cabinet is intended and in which the test has been made;

(b) the time/temperature curves (a), (b) and (c) (see **B.4.3.4**);

(c) the average mean temperature as a function of time (see **B.4.3.5**);

(d) if relevant (see **B.4.3.3**), the actual heat extraction rate at specified operating conditions and the measurements and calculations used to determine this rate.

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B.5 Test for air temperature within the net storage volume and energy consumption

B.5.1 *Procedure*

B.5.1.1 During the test, operate as normal any air circulating fans, automatic temperature controls and automatic defrosting devices. Run the cabinet at the selected test room climate class until the average temperature of the air within the net storage volume remains constant at the lowest temperature for which the cabinet is designed. (See also **B.4.1.**)

B.5.1.2 Run the cabinet for a further period of 24 h at the selected test room climate class and take and record the following measurements:

(a) percentage running time;

(b) total energy consumed in 24 h (kW);

(c) air temperatures within the net storage volume; record the temperature values at intervals of not more than 15 min; in the case of cabinets with automatic defrosting, record the internal air temperatures during the defrosting period;

(d) temperature shown by the temperature-indicating device; record these temperatures at the same intervals as the air temperatures at (c).

B.5.2 *Test report*

B.5.2.1 For cabinets not fitted with automatic defrosting devices, the test report shall include the following temperatures, calculated from the air temperature measurements (see **B.5.1.2**(c)):

(a) average air temperature in the net storage volume;

(b) highest air temperature in the warmest part of the net storage volume;

(c) lowest air temperature in the coldest part of the net storage volume.

B.5.2.2 For cabinets fitted with automatic defrosting devices, the test report shall include the following temperatures, calculated from the air temperature measurements (**B.5.1.2**(c)):

(a) average air temperature in the net storage volume excluding temperature measurements taken during automatic defrost cycles;

(b) highest air temperature in the warmest part of the net storage volume, excluding temperature measurements taken during automatic defrost cycles;

(c) lowest air temperature in the coldest part of the net storage volume, excluding temperature measurements taken during automatic defrost cycles;

(d) the highest air temperature recorded within the net storage volume during the 24 h test period.

B.5.2.3 For cabinets fitted with automatic defrosting devices, the test report shall include the number of defrosts during 24 h and the percentage of the total time of 24 h that is taken by the defrost operation.

B.6 Additional temperature tests

Repeat the test specified in **A.5** in an ambient temperature of 10 °C and record the results.

B.7 Defrosting test

B.7.1 *Procedure*

Load the cabinet as for the test on the temperature of contents (see **B.4.3**), operate it in accordance with the manufacturer's instructions at the conditions appropriate to the class (or classes) of test climate for which it is intended, and then operate it for at least 48 h after stable operating conditions have been reached.

NOTE. The temperature test may be carried out at the same time.

At the end of the defrost period, examine all surfaces, excluding test packages, within the refrigerated space for any residual water, ice or frost.

If water, ice or frost is evident and/or if the temperature test performance level is not being maintained, continue the test for a further period of at least 48 h under the same test conditions and with no adjustment to the control device(s).

B.7.2 *Test report*

The test report shall include the following information:

(a) statement of type and description of defrosting method(s) for the cabinet or part of it;

(b) statement of each test climate for which the cabinet is intended and for which it has been tested;

(c) results of measurements and observations made after each test period defined in **B.7.1.**

B.8 Water vapour condensation test

B.8.1 *Procedure*

At the conclusion of each of the tests described in **B.5** and **B.6**, check whether or not condensation is visible on the outer surface of the cabinet to the eye of a trained observer during a period of 12 h after the test conditions have become stable. Use a quick-acting temperature sensitive probe to check the temperature of the exterior surface of the cabinet. Check for moisture dripping or splashing from baffles, drip trays or other cold parts onto the test packages (see **4.2.10.2**).

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B.9 Test for accidental mechanical contact

B.9.1 *Apparatus*

B.9.1.1 *Test fingers*, as specified in BS 3456 : Part 201 (see figure 1), comprising a jointed test finger and a straight unjointed test finger of the same dimensions.

B.9.2 *Test procedure*

B.9.2.1 Disconnect the cabinet from the electrical supply and position moving parts (for example, fan blades) so that they are as close as possible to the test finger.

B.9.2.2 Remove all parts which can be removed without the use of tools, except the panels within the storage volume, for example those which cover the air ducts and the fan(s), even if these panels are able to be removed without the use of tools.

B.9.2.3 Apply the test fingers with the least force necessary, with the fingers and the cabinet in every possible position except that a cabinet normally used on the floor and having a mass exceeding 40 kg shall not be tilted.

B.9.2.4 Test apertures preventing the entry of the jointed finger further by means of the unjointed finger, applied with a force of 30 N; if this finger enters, repeat the test with the jointed finger, the jointed finger being pushed through the aperture if necessary.

B.9.3 *Test report*

The test report shall include the following information:

(a) whether or not the jointed finger enters into contact with moving parts;

(b) whether or not the unjointed finger enters into any aperture;

(c) whether or not the jointed finger afterwards enters into contact with moving parts.

B.10 Summary of test reports

The following data shall be reported for all cabinets:

(a) climate class (see **B.4.3.6**)[1];

(b) percentage running time (see **B.5.1.2**)[2];

(c) total energy consumed in 24 h expressed in kilowatt-hours; for cabinets intended to be switched off at night the total energy expressed in kilowatt-hours per 10 h (see **B.5.1.2.**);

(d) air temperature as calculated (see **B.2.5.1** and **B.2.5.2**);

(e) temperature of the warmest and coldest M-packages (see **B.4.3.4**);

(f) type of defrost method; number of defrost cycles per 24 h; time taken by defrost per 24 h (see **B.7.2** and **B.5.2.3**);

(g) observations regarding water vapour condensation (see **B.8**);

(h) observations regarding mechanical contact (see **B.9.3**).

[1] Where a cabinet is tested at more than one climate class, results are to be recorded for each class.

[2] In order that there should be reserve refrigerating capacity to deal with the various cooling loads that can be encountered in normal service, the percentage running time should not normally exceed 75 % under conditions of minimum average cabinet air temperature and maximum ambient temperature for which the cabinet is designed.

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Publication(s) referred to

BS 613	Specification for components and filter units for electromagnetic interference suppression
BS 800	Specification for limits and methods of measurement of radio interference characteristics of household electrical appliances, portable tools and similar electrical apparatus
BS 1224	Specification for electroplated coatings of nickel and chromium
BS 1586	Methods for performance testing and presentation of performance data for refrigerant condensing units
BS 1608	Specification for electrically driven refrigerant condensing units
BS 2048	Specification for dimensions of fractional horse-power motors
BS 2502[1)]	Specification for manufacture of sectional cold rooms (walk-in type)
BS 2754	Memorandum. Construction of electrical equipment for protection against electric shock
BS 3042	Specification for standard test fingers and probes for checking protection against electrical, mechanical and thermal hazard
BS 3053	Specification for commercial refrigerated cabinets for the sale and/or display of food products
BS 3456	Specification for safety of household and similar electrical appliances Part 201 General requirements
BS 3955	Specification for electrical controls for household and similar general purposes
BS 4434	Specification for safety aspects in the design, construction and installation of refrigerating appliances and systems
BS 4580	Specification for number designation of organic refrigerants
BS 4941	Specification for motor starters for voltages up to and including 1000 V a.c. and 1200 V d.c. Part 1 Direct-on-line (full voltage) a.c. starters
BS 4999	Specification for general requirements for rotating electrical machines Part 105 Classification of degrees of protection provided by enclosures for rotating machinery Part 111 Specification for built-in thermal protection for electric motors rated at 660 volts a.c. and below
BS 5000	Rotating electrical machines of particular types or for particular applications Part 11 Small-power electric motors and generators
BS 5267	Specification. Capacitors for single phase a.c. motors
BS 5420	Specification for degrees of protection of enclosures of switchgear and controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c.
BS 5424	Specification for control gear for voltages up to and including 1000 volts a.c. and 1200 volts d.c. Part 1 Contactors
BS 5643	Glossary of refrigeration, heating, ventilating and air-conditioning terms
BS 6148	Methods of test for commercial refrigerated cabinets Part 6 Electrical energy consumption test
BS 6206	Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings
BS 6500	Specification for insulated flexible cords and cables

IEE Wiring Regulations for Electrical Installations. IEE, Savoy Place, Victoria Embankment, London WC2R 0BC.

[1)] Referred to in the foreword only.

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