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Specification for

Microbiological safety cabinets

Spécification des cabinets de sécurité microbiologique

Spezifikation für mikrobiologische Sicherheitsschränke

British Standards Institution

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Foreword

This British Standard was prepared under the direction of the Surgical Instrument and Medical Equipment Standards Committee as the result of a request endorsed by the Department of Health and Social Security.

This standard does not specify requirements regarding dangers that may be associated with the use of volatile toxic, corrosive or radioactive substances.



British Standard Specification for

Microbiological safety cabinets

1. Scope

This British Standard specifies basic requirements for microbiological safety cabinets of the following types:

Class I. Open-fronted exhaust cabinets designed for use by one operator only.

Class II. Open-fronted exhaust cabinets flushed by a unidirectional downward air flow.

Class III. Enclosed exhaust cabinets.

The cabinets specified in this standard do not meet all the requirements that may arise for microbiological safety cabinets. The principles involved and the methods of test described have wide application but where special cabinets are constructed for particular purposes the onus of establishing their effectiveness has to rest with the users.

Four appendices are included:

- A Determination of the protection factor for class I and class II cabinets
- B Air velocity measurements
- C Tests for cabinets and filters
- D Notes for users

Sketches illustrating the three classes of cabinet and other fitting and test equipment are also provided.

2. References

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

3. Definitions

For the purposes of this British Standard the following definitions apply.

3.1 microbiological safety cabinet. A cabinet intended to offer some protection to the user and environment from the hazards of handling infected material and other dangerous biological material, but excluding radioactive, toxic and corrosive substances, any air discharged to the atmosphere being filtered.

NOTE. Microbiological safety cabinets are intended to reduce risk to the operator when handling dangerous biological materials but do not necessarily protect the operator from all the hazards involved. Some types may also protect the materials being handled in them from environmental contamination.

3.2 class I microbiological safety cabinet, open-fronted exhaust. A safety cabinet with an opening through which the operator can carry out manipulations inside the cabinet, air being continuously exhausted from the cabinet at sufficient rate to prevent the escape of airborne contamination generated within the cabinet.

3.3 class II microbiological safety cabinet, unidirectional (laminar) flow. A partially enclosed cabinet in which the work space is flushed with a unidirectional (so-called laminar) downward air flow and which is so constructed as to minimize, by means of an inward air flow through the working aperture, the escape of particles generated within the cabinet.

3.4 class III microbiological safety cabinet, enclosed exhaust. A safety cabinet by which the operator is separated from the work by a barrier, e.g. by gloves mechanically attached to the cabinet, and from which the escape of any airborne particles is prevented by an exhaust system.

3.5 internal dimensions. The measurements of the part of the cabinet that is accessible through the working aperture.

3.6 working space. The part of the interior of the cabinet within which manipulation may be safely carried out.

4. Overall dimensions

The dimensions of any cabinet, excluding any easily detachable parts, shall be such that it will pass through a doorway 2.0 m high by 0.9 m wide opening off a corridor 1.5 m wide.

5. Materials and construction

5.1 Main structure. The cabinet shall be constructed of suitable corrosion-resisting and fire-resisting materials, e.g. stainless steel, or other suitable material such as mild steel or aluminium alloy, provided it has a corrosion-resistant finish.

Cracks and surface defects including those leading to ineffective mating with gasket surfaces or other sealing devices shall be absent.

The feet or undersurface of cabinets shall be such that the point of instability is not reached with the application of lateral forces of up to 250 N or with the application of a downward force of up to 500 N on the front edge. If this is not achieved by the cabinet structure itself, provision shall be made for clamping or bolting the cabinet to the bench, floor or wall. The exhaust air duct shall not be used as a means of providing stability.

5.2 Windows. Windows shall be constructed of laminated or toughened glass of not less than 6 mm thickness, or of other suitable transparent plastics material.

NOTE. Where procedures with risk of explosion are involved, adequate additional protective screening will be necessary.

5.3 Sealing materials. All joints not welded shall be sealed with materials not liable to crack, e.g. synthetic rubber. Porous materials shall not be used.

5.4 Finishes. All internal finishes should be resistant to solvent, to disinfectant and to abrasion, and should be such that glare from the lighting is avoided.

5.5 Cabinet floor. The base of the cabinet shall be flat and rigid so that flexing of the surface cannot create dangerous conditions inside the cabinet. If the working space has a solid floor, this shall be liquid-tight with a raised edge at least 10 mm high all round so as to contain any spillage. If the floor is perforated, as in some class II cabinets, then the sub-floor into which any spilt liquid may drain shall be liquid-tight with a raised edge at least 10 mm high all round and the perforated floor shall be readily removable to allow easy access to the sub-floor for cleaning.

5.6 Internal corners and angles. All internal corners and angles shall be free from cracks and crevices and shall be radiussed.

5.7 Front sealing panel. A front sealing panel covering the open aperture of class I and class II cabinets shall be provided. The panel shall be made of rigid, non-flammable, non-corrodible material and shall be easily and quickly attachable and removable by means of simple spring toggle or finger screw operation. The seal shall be suitable for fumigation with formaldehyde (see appendix D). Rubber seals shall be so designed that there is no danger of their coming loose with frequent usage, i.e. shall be attached by riveting outside the sealing area.

5.8 Dual-purpose cabinets. If the construction otherwise complies with that specified for class III cabinets, a class I cabinet may be converted to a class III cabinet by the use of a front panel fitted with glove ports and an inlet filter. When attached, the sealing of the panel shall be capable of passing the leakage tests and the filter shall be as specified for class III cabinets.

5.9 Modular construction. When cabinets are joined together end to end, the junctions shall be airtight and shall not put undue stress on the cabinets or any junction or adaptor pieces. Sealing gaskets or mating surfaces shall not leave internal cavities or crevices.

NOTE. Attention should be paid to vibration as excessive vibration may damage seals and gaskets.

6. Requirements for electrical equipment and lighting

6.1 Electrical equipment. Motors shall not present an explosion hazard.

NOTE. The Department of Health and Social Security require that safety cabinets comply with the Electrical Safety Code for Hospital Laboratory Equipment*. It is recommended that where the extract fan is installed remote from the safety cabinet and forms part of a dedicated extract system, the installation should be in accordance with the current IEE Wiring Regulations for electrical installation†.

6.2 Lighting. Illumination at the work surface shall be a minimum of 1000 lux (1000 lumens per square metre). Control gear shall not be mounted inside the working space and shall be accessible from outside the cabinet. If internal light sources are required they shall be moisture-proof fittings.

7. Gas fittings (see appendix D)

If there is provision for gas supply to the inside of the cabinet (e.g. for bunsen burners) this shall be controlled by a solenoid valve that will allow gas to pass only when the fan is switched on and that needs to be manually reset after any

* Published by Her Majesty's Stationery Office.

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† Obtainable from the Institution of Electrical Engineers, PO Box 8, Hitchin, Herts SG5 1RS

‡ US MIL STD 282, published 28 May 1956, is obtainable from the Defense Information Centre Station Square House, St. Mary Cray, Orpington, Kent BR5 3RE.

interruption of the current. This will reduce the explosion hazard.

NOTE. Low-profile micro burners with lever control to give full flame only as required produce least disturbance of the air flow.

Gas fittings shall not be provided in class III cabinets. For class I and class II cabinets see D.7.

8. Ultraviolet lamps

The provision of an ultraviolet source for disinfection purposes is not recommended (see D.10).

9. Filters

9.1 The main exhaust filter shall be mounted in such a way that no air can by-pass the filter medium (i.e. the filter shall be virtually part of the external wall of the cabinet or an extension thereof, *not* mounted within the exhaust ducts (see figure 5).

NOTE 1. It is recommended that the main exhaust filter is sited directly on the cabinet.

The filter shall have a penetration not exceeding 0.003 % at the filter manufacturer's designed volumetric rate when tested with sodium chloride in accordance with BS 3928.

NOTE 2. The test method for dioctyl phthalate (DOP) described in US MIL STD 282‡ may be used as an additional procedure to the sodium chloride penetration test. The sodium chloride penetration test may not necessarily detect pinhole leaks in the filter matrix.

NOTE 3. It is recommended that a suitable prefilter, e.g. one having a gravimetric efficiency of 95 % against test dust no. 2 when tested at the designed flow rate in accordance with BS 2831, should be provided to extend the life of the main filter, and should be readily accessible from within the cabinet for easy changing.

9.2 Sampling ports shall be fitted to facilitate filter testing (see appendix C) in such a position that an average sample can be obtained.

9.2 Sampling ports shall be fitted to facilitate filter testing (see appendix C) in such a position that an average sample can be obtained.

10. Exhaust fan and effluent air

10.1 Each cabinet shall be so constructed that it can be exhausted to atmosphere by an individual fan mounted downstream of the filter and as near to the outside discharge end as possible. A cabinet with an integral fan shall discharge to outside atmosphere only by a short direct airtight duct (less than 2 m in length). If such short duct connections are not possible, the fan shall be situated separate from the cabinet and close to the discharge end so that any substantial length of ducting is under negative air pressure.

A class II cabinet may require an additional fan downstream of the exhaust filter. The fan shall be as near to the outside discharge end as possible and electronically interconnected with the main cabinet fan so that they operate simultaneously.

10.2 The air extraction system shall be capable of dealing with external wind conditions and duct resistances and the manufacturers shall specify maximum allowable external resistances to air flow. Allowance should be made for wind pressure up to at least 250 Pa (approximately 25 mm of water).

10.3 The extract duct work shall be suitably labelled (e.g. with a bio-hazard label) so that it is clearly apparent to maintenance personnel.

10.4 The cabinet shall be fitted with an automatic anti-blowback system downstream of the filters to prevent air flowing back into the cabinet, particularly when the fan is switched off. Anti-blowback valves shall be constructed so that the valve seats can be easily inspected and cleaned. The internal components shall be visible at all



times. Any micro switches or other electrical components shall be outside the duct.

10.5 An indicator, clearly visible to the operator, of the adequacy of airflow flow shall be provided for class I and class II cabinets and shall give clear signals in both safe and unsafe conditions (see figure 6). A manometer showing the pressure drop across the filter(s) is not satisfactory for this purpose.

11. Noise level

The noise level generated by a cabinet may be specified by the purchaser but shall not exceed 65 dB(A) when measured using a sound-level meter complying with the requirements of BS 3489 and when situated at 0.3 m from the opening of the cabinet. ~~The background noise level should be less than 55 dB(A) during the measurement.~~ Attention is drawn to the requirement of the Control of Pollution Act 1974: Part 3 regarding the noise emitted at the discharge point of the extract system.

12. Performance

1 A production model of class I and class II cabinets shall have been tested in accordance with the procedures described in appendix A and shall have shown a protection factor of not less than 10^5 as therein defined. Class II cabinets shall have satisfied the external contamination and cross contamination tests described in A.2.3 and A.2.4. Class III cabinets shall show no leaks when tested in accordance with C.1 and C.2.

1 Any cabinet that does not differ from the production model tested shall be deemed to comply with the requirements of this standard.

13. Information and marking

The manufacturer shall provide the purchaser with adequate instructions for:

- installation, including overall dimensions, the clearance required for access and the weight of heavy equipment;
- operation;
- maintenance, including recommendations for disinfection of the cabinet and for replacement of filters.

He shall also provide:

- an air flow diagram;
- information giving the limits of the effective working space and indicating any areas, e.g. near the front aperture, that are not protected;
- warning as to cleaning agents known to be incompatible with sealing material and finishes.

The cabinet shall be clearly and visibly marked in a permanently exposed position with the following:

- name of the manufacturer;
- the number of this British Standard, i.e. BS 5726.

14. Class I microbiological safety cabinets, open-fronted exhaust

See figure 1.

14.1 Dimensions. Open-fronted exhaust cabinets shall not exceed the following overall dimensions:

width: 1000 mm
depth: 750 mm

14.2 Working space. The width of the working space shall not exceed 1 m. The depth of working space shall be between 0.5 m and 0.7 m. The minimum height shall be 0.6 m. The volume of the working space shall be between 0.20 m³ and 0.45 m³.

14.3 Front window. The front window shall be sealable for fumigation and should be openable for ease of access to the working area when it is safe to do so.

Means shall be provided to hold the front window safely out of the way to enable the operator to have easy safe access to the working area for cleaning, setting up equipment, etc.

A clear view into the working space shall be given with the operator seated centrally at the cabinet with his eyes approximately 300 mm away from the window. The size, position and angle of the window shall be such as to give this view. An angle between 55° and 75° to the horizontal has been found to be satisfactory.

14.4 Working aperture. The following dimensions shall apply:

clear width of working aperture: 750 mm to 900 mm
height of working aperture: 200 mm to 250 mm

14.5 Air flow

14.5.1 The cabinet should be designed so that the velocity at any point of the working aperture does not fall outside the specified limits at the points specified in 14.5.2.

14.5.2 Air velocity measurements shall be taken in accordance with appendix B over at least 5 min at at least five positions, namely at the geometric centre of the aperture and at each of its four corners, with the centre of the measuring device between 50 mm and 55 mm from the right-hand or left-hand edge and from the top or bottom.

14.5.3 The measured velocities at all points with unused filters shall be between 0.7 m/s and 1.0 m/s.

NOTE. Higher velocities may lead to a worsening of performance due to the development of high-speed eddies.

14.5.4 Smoke or other visualization tests, e.g. water fog, shall demonstrate that the direction of air flow is inwards over the whole area of the working aperture.

14.6 Other requirements

14.6.1 After the construction the carcass shall be examined in accordance with C.1 and any defects shall be remedied.

14.6.2 After assembly the cabinet shall be tested in accordance with C.2 and C.3 and any defects shall be remedied.

14.7 Dual purpose. If the cabinet is convertible into a class III cabinet by the addition of a door with glove ports and the fitting of an inlet filter, the cabinet shall then

15. Class II microbiological safety cabinets, unidirectional (laminar) flow (downflow)

See figures 2 and 3.

Class II safety cabinets are designed to control airborne contamination that might be harmful to the experiment while, at the same time, reducing the exposure of the laboratory staff and the environment to airborne dispersal of infectious material during the procedures. These cabinets should not be confused with laminar-flow clean work stations, which usually discharge horizontally towards the worker and which provide no protection but may even increase exposure to airborne hazards.

15.1 Design and dimensions

15.1.1 The design should avoid unfiltered air under positive pressure. The balance between the inflow and downflow of air is critical in the design, which should minimize danger to the operator as well as cross contamination within the working space.

15.1.2 The delivery area for the air supply shall be identical in shape and area with the work area, without interposed projections or cavities, in order to ensure an uninterrupted air flow.

15.1.3 The sides and front window shall be such as to maintain a constant cross section for the air flow.

15.1.4 The width of the working space shall not exceed

1200 mm. The depth of the working space shall be between 450 mm and 600 mm but this implies a floor depth of up to 700 mm in order to accommodate the face air drawn in through the working aperture. The minimum height shall be 600 mm. The volume of the working space shall be between 0.2 m³ and 0.5 m³. The extent of the safe working area, behind that affected by the face air, shall be clearly indicated.

15.2 Front window. A front window shall be provided and shall be fixed, sliding, or hinged and sealable. It shall give a clear view of the whole working space.

15.3 Front aperture. The front aperture shall be the full width of the working space below the front window. The lower edge shall be formed in a manner that avoids turbulence at the entry. The vertical dimension of the working aperture shall be between 200 mm and 300 mm.

15.4 Air flow

15.4.1 The mean velocity of the downward air flow shall be between 0.25 m/s and 0.5 m/s.

15.4.2 Downward air velocity measurements shall be taken in the horizontal plane 100 mm above the top edge of the working aperture. The measurements shall be made in accordance with appendix B over at least 5 min at at least eight positions, namely four along a line one quarter of the depth of the working space forward of the rear wall and four along a line the same distance behind the front window. They shall be spaced along these lines at one-eighth and three-eighths of the width of the working space from both the left-hand and right-hand side. No single measurement shall differ from the mean of all the measurements by more than 20 % of this mean.

15.4.3 The mean flow velocity inwards through the working aperture shall be not less than 0.4 m/s.

15.4.4 The inward air velocity shall be determined by estimating the volumetric rate of discharge of effluent air from the cabinet and dividing this by the cross-sectional area of the working aperture. Smoke or other visualization tests, e.g. water fog shall demonstrate that the direction of air flow is inwards over the whole area of the working aperture.

15.5 Other requirements

15.5.1 After construction the carcass shall be examined and tested in accordance with C.1 and any defects shall be remedied.

15.5.2 After assembly the cabinet shall be tested in accordance with C.2 and C.3 and any defects shall be remedied. These tests shall be repeated after installation.

15.5.3 After 4 h continuous running with the fan(s) working and the lights on the air temperature inside the cabinet 100 mm above the centre of the working floor shall not have risen more than 8 °C above the ambient air temperature 100 mm in front of the centre of the working aperture.

16. Class III microbiological safety cabinets, enclosed exhaust

See figure 4.

16.1 General. Enclosed exhaust cabinets shall present a positive seal at all times in the sense that leakage of biological particles cannot take place in the event of fan failure and the worker is separated from the work by gloves that are continuous with the shell of the cabinet. Provision shall therefore be made to prevent backward flow of aerosol through the air intake by the fitting of an inlet filter that

also provides a supply of sterile air to flush the interior and prevent contamination of the material being handled.

16.2 Dimensions.

The overall dimensions shall comply with the requirements specified in clause 4.

16.3 Front window. The front window may be openable for ease of access to the working area when it is safe to do so. Means shall be provided to hold the window safely in the open position and to clamp it firmly sealed when in use.

A clear view into the working space shall be given with the operator seated centrally at the cabinet with his eyes approximately 300 mm away from the window. The size, position and angle of the window shall be such as to give this view.

16.4 Glove ports. Access to the working space shall be by glove ports.

NOTE. The recommended distance between centres of the glove ports is 460 mm.

16.5 Gloves (gauntlets)

16.5.1 The gloves, which shall be ambidextrous, shall have a beaded cuff conforming to the diameter and shape of the glove ports.

16.5.2 Gloves shall preferably be made of translucent natural rubber material so that damage to the glove may be more readily detected.

16.5.3 Gloves shall be easily replaceable from outside the cabinet so that the old gloves can be pushed inside the cabinet and new ones fitted whilst the fan is still running.

16.6 Glove port assembly

16.6.1 Glove port assemblies may be of two types:

- (a) permanently welded or riveted to or pressed from the front panel of the cabinet;
- (b) attached to the wall of the cabinet by fasteners with sealing gaskets.

16.6.2 The port assembly shall fulfil the following criteria:

- (a) It shall comply with the physical and chemical requirements specified in clause 5 for the shell of the cabinet (for example, the requirement for corrosion resistance).
- (b) Its dimensions shall be such as to provide for attachment of standard, commercially available beaded glove-box gauntlets without undue tension on the rim of the glove. The manufacturers shall specify the glove cuff diameter or shape appropriate to the particular port size.
- (c) The outer side of the port ring shall be provided with two grooves to accommodate the beaded cuff of the gauntlet and a secondary O-ring to provide an additional margin of safety and ensure glove change without compromising the seal.
- (d) It may include, as an optional extra, an efficient bung providing an absolute seal to enable fumigation of the cabinet if used as a class I cabinet.

A bung that can be fitted to the port internally or externally (i.e. reversible) is of advantage since it enables glove ports to be used as transfer ports and for the attachment of transfer bags.



16.7 Air flow

16.7.1 The air flow shall be sufficient to ensure an air velocity of at least 0.75 m/s through the ports when both gloves are detached. The air flow through the inlet filter shall be not less than 3 m³/min when the gloves are attached.

16.7.2 The inlet filter shall be to the same specification as the exhaust filter (see 9.1 and 9.2) and shall be of a size appropriate for passing the specified air flow at a negative pressure in the cabinet of 200 Pa (approximately 20 mm of water) and this shall be the minimum working pressure. A sealing plate shall be provided.

16.7.3 A manometer with a range of 0 kPa to 1 kPa (approximately 0 mm to 100 mm water) shall be mounted on the cabinet to give visual indication of the pressure of the interior.

16.8 Tests

16.8.1 After construction the carcass shall be examined and tested in accordance with C.1 and any defects remedied.

16.8.2 After assembly the cabinet shall be tested in accordance with C.2 and C.3 and any defects remedied.