BRITISH STANDARD

BS 5295-2: 1989

Incorporating Amendments Nos. 1 and 2

Environmental cleanliness in enclosed spaces —

Part 2: Method for specifying the design, construction and commissioning of clean rooms and clean air devices

ICS 13.040.30

Committees responsible for this British Standard

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Association of the British Pharmaceutical Industry
British Occupational Hygiene Society
British Surgical Trades Association Incorporated
British Telecommunications plc
Chartered Institution of Building Services Engineers
Department of Health
HM Treasury (Central Computer and Telecommunications Agency)
Heating and Ventilating Contractors' Association
Institute of Environmental Science and Technology
Institute of Sterile Services Management
Medical Sterile Products Association
Ministry of Defence
Parenteral Society
Society of British Aerospace Companies Limited
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Surgical Dressings Manufacturers Association
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Contents

Foreword

IMPORTANT NOTE. It is essential that this part is read in conjunction with BS 5295-0, issued separately.

This part of BS 5295 has been prepared under the direction of the Laboratory Apparatus Standards Policy Committee.

This revision supersedes BS 5295-2:1976, which is withdrawn.

The principal differences between BS 5295-2:1976 and this edition are:

a) it is prepared as a method for specifying instead of a guide to construction and installation; and

b) it includes many of the subjects previously covered by BS 5295-1:1976, but not directly related to the classification of environmental cleanliness.

Upon publication of BS EN ISO 14644-1:1999, BS 5295-1 and BS 5295-4 were withdrawn.

BS 5295-0, -2 and -3 have been amended pending publication of further parts of BS EN ISO 14644, when they will be withdrawn.

PD 6609:1996, which provides supplementary guidance to BS 5295-1:1989, has also been revised and will be withdrawn upon publication of further parts of BS EN ISO 14644.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 10, an inside back cover and a back cover.

The BSI copyright notice displayed in this document indicates when the document was last issued.

Sidelining in this document indicates the most recent changes by amendment.

1 Scope

This part of BS 5295 describes a method for specifying requirements for clean rooms and clean air devices. It is intended for use by purchasers of clean air installations and provides a check list of design, construction, furniture and fittings, and commissioning requirements which might or might not be relevant. Further guidance in respect of these requirements is given in appendices A to H.

This part of BS 5295 does not give detailed recommendations concerning the control or level of microbiological contamination, but allows for them to be agreed by interested parties.

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 part of BS 5295, the definitions given in BS 5295-0 apply, except where they are superseded by those given in BS EN ISO 14644-1:1999.

3 Information to be supplied by the purchaser to the supplier

NOTE A summary of the information to be supplied is given in Table 1.

3.1 Essential information

The information listed in items a) to g) shall be supplied by the purchaser to the supplier, if necessary in consultation with the user and/or supplier.

a) The number and date of this British Standard, i.e. BS 5295-2:1989.

b) The required class or classes of environmental cleanliness in accordance with BS EN ISO 14644-1:1999 and details of their associated states of occupancy as specified in clause **4** of this part of BS 5295.

NOTE It may be necessary to specify the cleanliness of a controlled space for more than one state of occupancy, e.g. class E (unmanned) [class G (manned)].

c) The general purpose for which the controlled space is to be used, the operations to be carried out and any constraint to be imposed by the operating criteria.

d) The required schematic layout.

NOTE Guidance on the layout of controlled spaces is given in appendix A.

e) All critical dimensions, including those relating to the available space.

f) The services required.

NOTE Guidance on the provision of services is given in appendix G.

g) Responsibility for performing and witnessing commissioning tests and procedures.

NOTE Guidance on commissioning is given in appendix H.

3.2 Additional information

The additional information listed in items a) to g), as applicable, shall be supplied by the purchaser, if necessary in consultation with the user and/or supplier.

a) Any special requirements concerning design.

NOTE Guidance on design is given in appendix B.

b) Any special requirements concerning construction.

NOTE Guidance on construction is given in appendix C.

c) Any requirements for determining environmental cleanliness at sampling positions additional to those given in BS EN ISO 14644-1:1999.

d) Any requirements for periodic or continuous in-use monitoring and associated alarms, if required.

NOTE Requirements for monitoring are given in prEN ISO 14644-2:1998.

e) Any requirement for control of the following environmental parameters:

1) temperature and humidity (see clause **6**);

2) lighting and glare (see clause **7**);

3) noise and vibration (see clause **8**);

4) ventilation and air change rate.

NOTE Guidance on air movement and ventilation is given in appendix E.

f) Any requirements concerning microbiological contamination (see clause **9**).

g) Any special filtration requirements.

NOTE Guidance on air filtration systems is given in appendix D.

Table 1 — Summary of information required

Information required	Relevant clauses		Other related Parts, appendices and clauses
	Essential information	Additional information required	
Reference (i.e. the number and date of this British Standard)	**3.1** a)		
Class of environmental cleanliness and state of occupancy	**3.1** b)		Clause **4**
Purpose of the controlled space	**3.1** c)		
Layout	**3.1** d)		Appendix A
Dimensions	**3.1** e)		
Services	**3.1** f)		Appendix G
Responsibility for commissioning	**3.1** g)		Appendix H
Design		**3.2** a)	Appendix B
Construction		**3.2** b)	Appendix C
Additional sampling positions		**3.2** c)	Clause **5**
Monitoring positions		**3.2** d)	Part 4
Temperature and humidity		**3.2** e) 1)	Clause **6** Appendix F
Lighting and glare		**3.2** e) 2)	Clause **7** Appendix F
Noise and vibration		**3.2** e) 3)	Clause **8** Appendix F
Ventilation and air change rates		**3.2** e) 4)	Appendix E
Microbiological contamination		**3.2** f)	Clause **9**
Filtration systems		**3.2** g)	Appendix D

4 Occupancy state

NOTE 1 The definitions of occupancy states are given in clause **4** of BS 5295-0:1989.

If an occupancy state other than the as-built condition is required, the details for the appropriate occupancy state shall be supplied, as follows.

NOTE 2 The purchaser should fully understand the implications his selection of occupancy state will have for the supplier in designing, constructing and testing the clean room.

a) For the unmanned condition.

1) Details of all items of equipment to be installed by the purchaser, including all motors, pumps and other moving parts to be located in the clean room.

2) Details of all materials used within the clean room including quantities and methods of storage.

b) For the manned condition.

1) Details of all items of equipment to be installed by the purchaser, including all motors, pumps and other moving parts to be located in the clean room.

2) Details of all materials used within the clean room including quantities and methods of storage.

3) Details of the number of persons normally working in the room and their activities.

4) Details of the clean room garment regime, i.e. type of clothing, use of face masks, change and washing procedures, footwear, entry procedure, etc.

5) Details of materials handling disciplines within the controlled space.

5 Additional air cleanliness determinations

If the purchaser requires determinations of the classification of environmental cleanliness additional to those specified in BS EN ISO 14644-1:1999, the number and location of the additional sampling positions shall be agreed with the supplier. Otherwise the method of determination shall be as given in BS EN ISO 14644-1:1999.

6 Temperature and humidity

If limits of temperature (in °C) and humidity (in percentage saturation) are specified by the purchaser, the purchaser shall supply:

a) details of the amount of heat and moisture generated in the room, the location of sources and the nature of their dynamic variation;

b) the details of the outside conditions under which the system is required to operate;

c) details of the point or points at which measurement is to be carried out, and the method to be used.

NOTE Guidance on temperature and humidity is given in appendix F.

7 Lighting and glare

If lighting levels are specified by the purchaser, the purchaser shall supply details of how the levels are to be assessed.

NOTE 1 Guidance on lighting is given in appendix F.

If a maximum glare index is specified by the purchaser, the glare index shall be determined by the method given in appendix 3 of The Chartered Institution of Building Services Engineers' Technical Memoranda 10 "The Calculation of Glares Indexes 1985".

NOTE 2 Guidance on glare indices is given in **F.3.2**.

8 Noise and vibration

If limits of acceptable noise and vibration levels are specified by the purchaser, the purchaser shall supply details of how the levels are to be assessed.

NOTE Guidance on noise and vibration is given in appendix F.

9 Microbiological contamination

Where for particular applications the level of microbiological contamination is of greater importance than the level of particulate contamination, the level to be met, the method of test and corresponding particulate contamination shall be specified by the purchaser. This shall be defined separately for manned and unmanned occupancy states.

Appendix A Guidance on the layout of controlled spaces

A.1 General

A.1.1 *Size*

The size of a controlled space should be kept to the minimum practicable allowing, so far as can be envisaged, for any future requirements. Large open spaces may present difficulties in environmental control. They are also likely to present problems in cleaning up contamination and to exhibit varying contamination levels within the space. In general, if a large amount of floor space is required it should be divided into several zones or rooms, with or without partitions, for the purposes of environmental control especially where a high level of cleanliness is required in more than one zone.

A.1.2 *Work positions*

Critical work positions should be sited away from exits, major traffic pathways and other features which may cause disruption of the airflow pattern and higher levels of contamination.

In horizontal flow controlled spaces the siting of work positions should be such that contamination generated by both personnel and work does not adversely affect adjacent work positions. When operations that require different degrees of cleanliness are to be carried out in an area in which directional air flow exists, dirtier operations should be sited downstream of cleaner operations.

A.1.3 *Services and facilities*

The amount of permanent services run within the controlled space should be kept to a minimum. To this end, the use of external service areas or ducts should be considered. Means should be provided for the effective removal of waste and contamination generated within the room. Whenever practicable, communication facilities should be provided in order to minimize the movement of personnel.

A.1.4 *Ancillary areas*

When laying out an installation consideration should be given to the location of ancillary areas and services such as cleaning, toilet and refreshment facilities.

A.2 Access

A.2.1 *General*

The number of openings connecting the controlled space to outside areas should be minimized. There should also be means to minimize the contamination arising from the entry or exit of personnel or material or from air movement. Normal (non-emergency) access to or access from the controlled space should be through airlocks for both personnel and materiel.

A.2.2 *Airlocks*

In order to maintain overpressure and integrity of the controlled space during entry and exit at least one airlock will normally be required. Precautions should be taken to ensure that entry and exit doors associated with an airlock are not opened simultaneously. In both cases doors should be provided with clear windows such that a line of sight view is provided between them. Consideration should be given to the use of electrical and/or mechanical interlock systems including audiovisual indicators.

Barrier benches or other demarcation systems and decontamination devices and procedures should be employed within an airlock system for the passage of materiel. Consideration should be given to segregation of passage of materiel and personnel.

A.2.3 *Emergency exits*

Emergency exits other than those through air locks should be provided with means to show that they have been opened.

A.3 Changing rooms

A.3.1 *General*

Changing rooms may be integral with the airlock entry arrangements to the controlled space or may be separate and provided with access to the space via an airlock. The airlock may incorporate an air shower.

A.3.2 *Changing room areas*

Changing rooms should be designed with three distinct sections having clear demarcations, e.g. by barrier or markings.

a) A “black area” providing direct access to the external environment of the controlled space. This area need have no environmental control.

b) A “grey area” where the level of environmental cleanliness lies somewhere between that of the “white area” and “black area” which acts as a transition zone when passing between the two areas.

c) A "white area" providing access to the controlled space either directly or via an airlock. This area should be maintained at or near the same level of environmental cleanliness as the controlled space.

NOTE For the purposes of this clause, the white, grey and black areas are all within the changing room area.

The barrier between the areas should be such that, in the normal course of events it acts as a physical barrier. Where necessary, a removable section should be incorporated to allow the entry of mobile equipment, etc.

The airflow in the changing room should be such that migration of contamination from the black side to the white side is minimized, i.e. there should be a positive airflow from the white to the black areas.

A.3.3 *Facilities in changing room areas*

The white area may incorporate washing facilities and a full length mirror for checking apparel. The opening of doors and the operation of taps and hand driers or waste bins (when present) should not require the use of washed hands.

The grey area should incorporate storage for clean room cleaning materials and equipment and provision should be made for the storage of clean room clothing separate from every day clothing and personal effects when not in use.

The black area may include safe storage for limited quantities of everyday clothing and also personal belongings such as handbags, watches, jewellery, etc. It should also include provision for the disposal or collection of used clean room garments, overshoes, etc. Some applications may require washing facilities, storage of cleaning materials and access to toilet facilities.

A.4 Windows

Windows on outside walls may lead to problems of heat loss, solar gain, condensation and noise, and therefore unnecessary external windows should be avoided. The use of internal windows should be considered to allow observation of activity within the room, without entry.

Windows should be non-opening, flush fitting and sealed.

When blinds are fitted they should be hung either outside the controlled space or enclosed within double glazing.

Appendix B Guidance on design concepts

The design should include provisions for the following.

a) *Filtration systems*. These should control the particulate content of the air entering the space in order to meet the requirements specified in clause **3**. This will include displacing contaminated air to outside as quickly as possible and avoiding the ingress of contaminated air into the space.

NOTE Advice on filtration systems is given in appendix D.

b) *Environmental control systems*. These should ensure that the environmental control requirements of clause **3** are met. Due consideration should be taken of the environment surrounding the controlled space, e.g. contamination and pollution, air patterns and weather.

NOTE Advice on environmental control systems is given in appendix F.

c) *A suitable layout*. This should prevent contamination of sensitive materials by ensuring that a suitable quality of environment is provided, including the provision of enclosures or covers. Consideration should be given to the location of equipment and services such that those parts not required to be in the clean environment are, where possible, outside it. Work procedures should be sited so as to produce as little contamination as possible.

NOTE Advice on layout is given in appendix A.

d) *Provision of services*. Services should be installed in such a manner that they do not prejudice the classification of the room. Provision should be made for the maintenance of systems, services and equipment without adversely affecting the operation of the controlled space, with the maximum amount of servicing carried out from outside and without violating the integrity of the space.

NOTE Advice on provision of services is given in appendix G.

e) *Suitable construction methods and materials*. The methods and materials used in construction should minimize the generation and retention of contamination. Surfaces should be capable of frequent and effective cleaning. Non-functional horizontal surfaces and crevices where contamination can collect should be avoided.

NOTE Advice on construction is given in appendix C.

f) *Provision for commissioning the room*. Suitable provision should be made within the design for full and effective commissioning of the installation.

NOTE Advice on commissioning is given in appendix H.

g) *Provision for ventilation*. Provision should be made for air movement ventilation.

NOTE Advice on air movement is given in appendix E.

Appendix C Guidance on the construction of installations

C.1 General

C.1.1 The purchaser should provide the supplier with all relevant information concerning the use of the installation, e.g. processes carried out, chemicals used, need to sterilize or disinfect. The construction should take full account of this information.

C.1.2 The construction of the installation and the materials used should comply with all the relevant British Standard specifications and codes of practice.

C.1.3 The purchaser should specify any special construction requirements, whether it be concerning methods or materials and finishes.

C.1.4 The method of construction should be selected so as to provide ease of penetration of the installation to permit the installation or removal of equipment and/or services with minimum disruption to the operation of the installation.

C.2 Methods of construction

C.2.1 The methods used in the construction of the clean room should be those appropriate to the class of controlled space and its intended use.

Methods of construction which generate significant amounts of contamination will lengthen the clean up time of the room and may prejudice its certification. However, this approach may be acceptable in the case of lower grade classes of controlled spaces.

C.2.2 All internal surfaces swept by the airflow should be smooth and free from cracks, ledges and cavities. The design and construction should be such that the number of ledges, cavities and similar places where contamination could collect are kept to a minimum.

C.2.3 The number of corners should be minimized, particularly internal corners. Wherever possible internal corners should be radiused, with a minimum radius of 25 mm.

C.3 Materials

C.3.1 The materials used in the construction of the installation should be consistent with the class of controlled space required and be suitable for their intended use. All materials should be non-shedding and suitable for effective and frequent cleaning.

C.3.2 The purchaser should specify where resistance to particular physical or chemical attack is required, e.g. aluminium filter separators should not be used where there is risk of chemical attack.

Under normal room conditions some materials, particularly metals, are prone to corrosion. For example, where uncoated steel is used it should be stainless steel, and where uncoated aluminium is used it should be anodized.

C.3.3 Materials used in the construction of controlled spaces should not generate or hold a significant static charge. What constitutes a significant static charge will vary with application and should be clearly specified by the purchaser. Many applications may require the use of conductive materials in order to minimize the influence of any induced static charge.

C.3.4 When selecting materials consideration should be given to potential fire hazards.

C.3.5 Materials used in the construction of the installation should be free from burrs and other surface irregularities which could prejudice the classification and operation of the room. Exposed fibrous materials, e.g. wood products and fibre boards, should be avoided, otherwise they should be treated to prevent the release of particulate contamination.

C.3.6 Attention should be paid to minimizing the contamination generated and retained in all air paths, even when they are prior to the main filters, in order that an excessive load is not placed on the filtration system. For example, ducts should be manufactured from materials with corrosion resistant and non-flaking properties, or should be given suitable surface treatment to prevent the introduction of contaminants from the duct.

C.4 Work in progress

C.4.1 All components and materials for use in the construction and subsequent maintenance of the installation should be packed, transported, stored and inspected before use in such a manner as to ensure their suitability for their intended use.

C.4.2 The construction of the installation should be carried out in such a manner that the amount of contamination generated during this phase is kept to a minimum and that any contamination present at this time will not affect the operation of the controlled space on completion. Particular attention should be given to the programming of the work, e.g. programming contaminant generating works early in the programme, prior to cleaning work.

C.4.3 All surfaces swept by the airflow, including the interior of all accessible ductwork and voids should be vacuum cleaned on completion of construction and prior to commissioning. The air movement system should not be run until this is completed. Before high efficiency filters are fitted the air movement system should be run for several hours, i.e. 24 h to 36 h, possibly with muslin bags over the duct ends to blow clear any detritus missed in the above cleaning.

C.4.4 Where the completed installation will not be accessible for cleaning it should be cleaned during assembly and then temporarily sealed and protected to prevent contamination.

C.4.5 Before high efficiency filters are fitted the accessible ductwork should be revacuum cleaned and inspected by the purchaser's agent.

C.4.6 Where possible high efficiency filters should be examined by and fitted in the presence of the purchaser's agent.

Appendix D Guidance on air filtration systems

D.1 Introduction

Air filtration systems should be designed to suit both the cleanliness level required and the conditions associated with their use in the system. Particular attention should be paid to the materials used in the construction of the filter to ensure that the filter element will not in itself generate particles due to fibre shedding or oxidation of any metal parts.

D.2 General

Filters should be packaged in a manner that adequately protects the element during normal handling and transportation from the manufacturer's works.

The fitting of filters should be delayed until they are required for commissioning purposes, having been stored in accordance with the manufacturer's instructions.

All final filters should be protected by a prefilter located on their upstream side. The prefilter should be chosen to prolong the life of the final filter.

NOTE A filter with an average atmospheric dust spot efficiency of 70 % to 90 % to BS 6540-1 should be fitted upstream of a high efficiency filter, and one with an average synthetic dust weight arrestance of 70 % to 90 % to BS 6540-1, upstream of a filter with an average atmospheric dust spot efficiency of 70 % to 90 % to BS 6540-1.

D.3 Testing

All high efficiency filters should be individually tested at the manufacturer's works to the satisfaction of the purchaser. The testing should include at least a scanning leak test and/or an efficiency test as follows.

a) *Efficiency test*. When applicable the efficiency test should be in accordance with BS 3928 (sodium flame).

NOTE 1 When sodium ion contamination of the filter is unacceptable to the purchaser, an alternative test method may be employed, e.g. using a suitable aerosol of dispersed oil particulate. If a method other than BS 3928 is used, then the test method and aerosol should be specifically defined by the supplier to the satisfaction of the purchaser, and should where possible be related to a recognized national or international standard.

b) *Leak test*. The leak test should be in accordance with the procedures laid down in PD 6609.

In addition to the above tests, some high efficiency filters may require certification of velocity uniformity across the filter face. If such certification is required by the purchaser, then the test method, average velocity required and mean deviation thereof should be specifically defined by the purchaser and agreed with the supplier.

NOTE 2 Velocities measured on the downstream side of a filter may differ from those measured in the ductwork due to a number of effects such as effective free area of the filter system, pressure changes throughout the system and induction effects.

D.4 Marking

High efficiency filters should be clearly marked in a prominent and easily read position with at least the following information:

a) manufacturer's name or trade mark;

b) manufacturer's model reference;

c) manufacturer's rated airflow capacity;

d) manufacturer's serial number, which uniquely identifies each filter;

e) filter efficiency at rated airflow and test method used;

f) resistance at rated airflow;

g) arrow showing direction of airflow during tests.

D.5 Documentation

In addition to any test results or certificates provided following the tests required by **D.3**, all high efficiency filters should be provided with certification of conformity following works testing, in compliance with the performance parameters required which includes at least the following:

a) manufacturer's name or trade mark;

b) manufacturer's model reference;

c) manufacturer's rated airflow capacity;

d) manufacturer's serial number, which uniquely identifies each filter;

e) filter efficiency at rated airflow and test method used;

f) resistance at rated airflow;

g) the testing authority;

h) the test methods used.

Appendix E Guidance on air movement and ventilation

E.1 Air movement and ventilation

The design should ensure that all spaces within the controlled space are swept efficiently by the airflow, in order to ensure that both contamination control and environmental control are carried out effectively and efficiently.

If the defined space incorporates a large volume not effectively swept by the airflow, the possibility of entrainment of this air compromising the environmental cleanliness should be considered.

In order to avoid undesirable draughts consideration should be given to the velocity, temperature and method by which air is delivered into the space.

Sufficient air of a suitable quality should be introduced into the space to maintain a safe and adequate air quality for the occupants.

E.2 Ducted air ventilation services

Ducted air ventilation services should be manufactured from materials with corrosion resistant and non-flaking properties, or should be given suitable surface treatment to prevent the egress of contaminants.

The system should retain the required airflow by either manual or automatic adjustment, to compensate for airflow as the filter resistance increases.

The fitment and disposition of closedown shutters should be considered for use when the controlled space is not operating.

Where closedown shutters are being used as part of a fumigation procedure, it is particularly important that they form an effective seal.

E.3 Microbiological contamination of ventilation system

In order to minimize the possibility of microbiological contamination of the ventilation system, consideration should be given to the likely sources of contamination, e.g. extracted moisture should be discharged to waste and not recirculated, humidification should be by steam injection (spinning disc or spray humidifiers should not be used) and ductwork should be adequately insulated in accordance with the relevant British Standard specification or code of practice.

Appendix F Guidance on the environmental control of controlled spaces

F.1 General

F.1.1 Requirements for environmental control will vary with application. Therefore the purchaser should state what criteria are important when specifying a controlled space. The list given in clause **3** is not exhaustive and should be treated as the minimum required.

F.1.2 The design of the environmental control systems should take account of the following:

a) safety and comfort of personnel;

b) needs of and constraints imposed by equipment and processes;

c) capital and operating costs;

d) sensible use of energy;

e) reliability, ease of operation and maintenance.

NOTE The CIBSE Guide[1)] contains information on the requirements for the performance design and construction, commissioning and operation of environmental controlled systems.

F.2 Temperature and humidity

F.2.1 If required, the purchaser should specify limits of temperature (in °C) and humidity (in percentage saturation, see BS 1339) within which the controlled space is required to operate.

[1)] The CIBSE Guide is available from the Chartered Institution of Building Services Engineers, Delta House, 222 Balham High Road, London SW12 9BS.

NOTE 1 Consideration should be given to the avoidance of excessive energy consumption by allowing the system to drift between limits rather than continually drive towards a fixed value or set-point.

The tolerances specified for temperature and humidity should be mutually compatible.

NOTE 2 It is very difficult to establish close humidity control with loose temperature control.

F.2.2 The purchaser should specify the outside conditions under which the system is required to operate. This should include the extremes of temperature and humidity expected throughout the year.

NOTE If suitable information is not available, the data in the CIBSE Guide[2)] may be used after adjustment for the particular location.

F.2.3 The purchaser should specify at which point or points in the controlled space the temperature and humidity are to be measured.

F.2.4 The purchaser should state the amount of heat and moisture generated in the controlled space, the location of sources and the nature of their dynamic variation.

F.3 Lighting

F.3.1 *General*

The purchaser should specify the lighting levels and uniformities required within the various parts of the installation and the methods used to assess them.

The colour of light should be specified by the purchaser as it has a significant effect on the comfort of personnel and in many cases the processes being carried out, especially photographic processes.

The lighting system should be consistent with the effective operation of a controlled space. Fittings should be flush, sealed and have no areas in which contamination may collect. The light fittings associated with a controlled space should be serviceable in a manner such that the integrity of the space is not violated and excessive contamination is not produced.

F.3.2 *Glare*

The effect of glare should also be considered, within the context of the work being carried out, e.g. when visual display screens are part of the process. Where it is important, the purchaser should specify the maximum permitted level of glare.

F.3.3 *Emergency lighting*

Consideration should be given to the provision of an emergency lighting system. Where emergency lighting is required it should be in accordance with BS 5266-1.

F.4 Noise and vibration

F.4.1 *Noise*

The purchaser should specify the acceptable noise levels within the various parts of the installation, how they are to be assessed and the conditions under which they are to be measured, whether they are total noise levels or those due to equipment.

In all cases the purchaser should indicate what equipment is to be running at the time of the test.

Noise levels should be assessed using the NR criteria, in order to provide an effective measure of the nuisance level of the noise.

F.4.2 *Vibration*

The purchaser should specify the level of acceptable vibration, particularly the critical frequency or frequencies, and the methods for their assessment.

The design should allow for the effect of all sources of vibration in the installation and its surroundings, including air movement, plant and machinery, people and traffic.

Consideration should also be given to the possibility of regeneration of vibrations in the structure producing noise.

Appendix G Guidance on the provision of services

G.1 General

Services provided for the controlled space area should be designed and installed such that the room integrity is not compromised by contamination from such services.

All services, when passing through the envelope of the controlled space should be adequately sealed to prevent air leakage that could otherwise compromise satisfactory room pressurization.

G.2 Mechanical services

G.2.1 *Piped liquids and gases*

Piped liquids and gases (e.g. water, chemicals and compressed air), should be filtered before entering the controlled space to ensure that the liquid or gas at the work position will be at a cleanliness level compatible with the requirements of the space.

[2)] The CIBSE Guide is available from the Chartered Institution of Building Services Engineers, Delta House, 222 Balham High Road, London SW12 9BS.

All pipe and pipe fittings should conform to the relevant British Standards.

Blanking covers should be provided and fitted wherever a service is out of use.

All materials used should be non-shedding and suitable for effective and frequent cleaning. They should be suitable for use with the fluids which are to pass through them.

G.2.2 ***Vacuum cleaning equipment***

Vacuum cleaning equipment, either portable or built in, should be provided to ensure that any particulate contamination which has settled can be removed during periodic cleaning, and to ensure that contamination generated by any operation that cannot reasonably be conducted outside can be continuously removed.

Ideally a permanent vacuum contamination removal system should be built in, with the exhaust and fan sited outside the controlled space. The terminating sockets in the controlled space should be blanked off when not in use. The airflow through the vacuum chamber should not compromise the overpressure of the space.

Portable vacuum equipment should comply with BS 5415-2.2:Supplement 1.

Portable vacuum equipment, if used, should be fitted with an exhaust filter of at least the same standard as that filtering the environmental air supply.

G.3 Electrical services

All electrical services should comply with the relevant edition of the Institution of Electrical Engineers (IEE) Regulations for electrical installations.

The number, type and siting of electrical sockets should be stated by the purchaser.

The use of overhead electrical sockets should be considered.

The use of electrical floor sockets should be avoided.

Blanking plugs or covers should be provided when an electrical outlet is not in use.

Appendix H Guidance on commissioning

H.1 General

The commissioning should be carried out by the supplier, with tests and procedures witnessed by the purchaser or his nominated representative as given in clause **3**.

The supplier should carry out tests to demonstrate compliance with the other requirements specified in clause **3**.

H.2 Cleaning before commissioning

Prior to the fitting of filters, and after cleaning as described in **C.4** has been completed, all ducts, walls, ceilings, floors and installed fittings that are swept by the air, should be thoroughly cleaned to remove contamination which could prejudice the classification of the controlled space.

Following cleaning, the final filters should be fitted and the commissioning tests conducted to demonstrate compliance in accordance with BS EN ISO 14644-1:1999.

H.3 Commissioning report

The reports of the commissioning tests should be presented in a documented manual. This manual should also include:

a) manufacturer's works testing during documentation;

b) calibration certificates of instrumentation used;

c) relevant drawings and as-installed details;

d) witnessed verification (see **H.1**) of compliance with specification.

Publications referred to

BS 1339, *Definitions, formulae and constants relating to the humidity of the air.*

BS 3928, *Method for sodium flame test for air filters (other than for air supply to I.C. engines and compressors).*

BS 5266, *Emergency lighting.*

BS 5266-1, *Code of practice for the emergency lighting of premises other than cinemas and certain other specified premises used for entertainment.*

BS 5295, *Environmental cleanliness in enclosed spaces.*

BS 5295-0, *General introduction, terms and definitions for clean rooms and clean air devices.*

BS 5415, *Safety of electrical motor-operated industrial and commercial cleaning appliances.*

BS 5415-2, *Particular requirements.*

BS 5415-2.2, *Specification for vacuum cleaners, wet and/or dry.*

BS 5415:Supplement No. 1, *Specification for type H industrial vacuum cleaners for dust hazardous to health.*

BS 6540, *Air filters used in air conditioning and general ventilation.*

BS 6540-1, *Methods of test for atmospheric dust spot efficiency and synthetic dust weight arrestance.*

BS EN ISO 14644-1, *Cleanrooms and associated controlled environments — Part 1: Classification of air cleanliness.*

PD 6609, *In-situ aerosol testing of HEPA filtration: An explanatory supplement to BS 5295-1:1989* [3].

pr EN ISO 14644-2, *Cleanrooms and associated controlled environments — Part 2: Specifications for testing and monitoring to prove continued compliance with ISO 14644-1.*

The Chartered Institution of Building Services Engineers' Technical Memoranda 10 "The Calculation of Glare Indexes 1985"[4].

The "CIBSE Guide"[4].

[3] Subject to revision.

[4] Available from the Chartered Institution of Building Services Engineers, Delta House, 222 Balham High Road, London SW12 9BS

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