

Guide to

# Design of measurement laboratories

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## Foreword

This British Standard has been prepared under the direction of the Management Systems Sector Board.

It is intended to provide guidance to those who may be involved in the design, construction, supply, purchase and use of laboratories, or modification of an existing laboratory, in which measurements will be carried out. Measurements can be complex, and can involve a wide range of technologies and requirements. Measurements are undertaken across an extremely wide field of applications, under differing environmental conditions, and it is likely that other criteria need to be considered for some laboratories, in addition to those given in this standard. It is, however, not possible within this guide to cover the design requirements for every type of laboratory. More specialized features for some specific types of laboratory are covered in Annex A, Annex B and Annex C. Other publications giving guidance on laboratory design are listed in the bibliography in Annex D.

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.

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### Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 14, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

## 1 Scope

This British Standard gives guidance on design criteria and considerations for the siting, construction, environment, supply of services and equipping of measurement laboratories, to ensure that measurements undertaken therein are valid and not adversely affected by environmental conditions. Guidance on acceptance tests is also given.

This British Standard does not cover the selection, installation or use of measuring instruments.

## 2 References

### 2.1 Normative references

This British Standard incorporates, by dated and undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on page 16. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

### 2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications, current at the time of issue of this standard are listed on page 16, but reference should be made to the latest editions.

## 3 Definitions

For the purposes of this British Standard, the definitions given in BS 5233:1986 apply together with the following.

### 3.1

#### measurement

the set of operations having the object of determining the value of a quantity

NOTE This definition is identical with **2.01** of BS 5233:1986.

### 3.2

#### measurand

particular quantity subject to measurement

*Example:*

vapour pressure of a given sample of water at 20 °C

NOTE 1 The specification of a measurand may require statements about quantities such as time, temperature and pressure.

NOTE 2 This definition is identical with **2.6** of PD 6461-1:1995 (which is identical with the *International vocabulary of basic and general terms in metrology*, ISO 1993).

### 3.3

#### influence quantity

a quantity which is not the subject of the measurement but which influences the value of the measurand or the indication of the measuring instrument

*Examples:*

ambient temperature; frequency of an alternating measured voltage

NOTE This definition is identical with **2.10** of BS 5233:1986.

### 3.4

#### measurement laboratory

place where measurements are carried out under controlled conditions

### 3.5

#### laboratory conditioned atmosphere

specified operating ranges of temperature and relative humidity within which the atmosphere of a measurement laboratory is controlled

### 3.6

#### reference conditions

conditions of use prescribed for testing the performance of a measuring instrument or for intercomparison of results of measurements

NOTE This definition is similar to **5.07** of BS 5233:1986.

### 3.7

#### stability

ability of a measuring instrument to maintain constant its metrological characteristics with time

NOTE This definition is similar to **5.16** of BS 5233:1986.

## 4 General considerations and operating conditions

**4.1** The laboratory environment can influence the results of certain types of measurement. It may therefore be necessary to control influence quantities to ensure that the desired accuracy of measurements is achieved, and that the results of measurements are within the stated uncertainty. It is also necessary to ensure that the laboratory equipment and processes are not adversely affected by their environment and that the laboratory provides comfortable working conditions for personnel. The detailed construction of a laboratory needs to vary according to its intended purpose and this should be agreed between the purchaser or user of the laboratory and the supplier.

For most measurement laboratories it is essential that the laboratory environment is controlled to maintain stable conditions, particularly over specified periods of time. A single specified standard atmosphere used by all laboratories would be the ideal but, because of the diversity of climates and measurement requirements, this is not possible (see 5.10.3).

A laboratory, either in a new building or in an existing one, usually requires a specification. The requirements and the tests for acceptance of the completed laboratory should be clearly and fully specified. Where plant to control the laboratory environment is required, its design should take account of the specified laboratory conditions, the construction of the building, the likely external ambient conditions and working conditions within the laboratory. It is essential that the plant designer is provided with all the details of the relevant factors that could affect the laboratory environment.

In practice it is not possible to test the performance of a laboratory under a wide range of external ambient conditions within a short period, as it is necessary to depend upon seasonal variations of the external environment. It is essential that a schedule of tests, to be carried out for accepting the completed laboratory, should be prepared and agreed between the supplier and the purchaser or user, as part of the laboratory specification. Relevant tests should be carried out over a specified and extended period to cover seasonal variations. More detailed recommendations on testing are given in clause 9.

**4.2** The basic criteria for siting, construction or modification, environmental conditions, supply of services and furniture apply to the majority of measurement laboratories.

The following major factors should be considered:

- a) the external and the required internal atmospheric conditions;
- b) the rate of air change required;
- c) the nature, accuracy and uncertainty of the measurements to be undertaken;
- d) the ambient noise and vibration;
- e) any electromagnetic or radiation effects;
- f) health and safety.

It is these factors that mainly dictate the constructional features of the laboratory and the required capacity of any air conditioning plant.

**4.3** Other environmental features that need to be considered are illumination (both general and at working positions), operator comfort, air pressure and air pollution.

**4.4** Measurement techniques are continually advancing, along with demands for higher accuracies, so when considering a new laboratory the design should allow for future modification to provide flexibility of operations and possibly later expansion and improvements.

**4.5** It is recommended that the management of the design of a measurement laboratory should follow the guidance given in BS 7000-1:1989 and that particular regard should be given to section 3 of that standard.

## 5 Selection of site and design criteria

### 5.1 General

The site for a laboratory should be chosen with considerable care, paying particular attention to the nature and accuracy of the measurements to be undertaken and any local conditions that could affect the constructional and operational aspects. The factors given in 5.2 to 5.12 should be considered during the planning and design stages since they could affect the operational performance of the laboratory. These criteria are not universally applicable however, and for specialized laboratories more exacting environmental controls, and additional features and services may need to be incorporated.

Additional considerations for some specific types of laboratories are covered in Annex A, Annex B and Annex C as follows:

- a) Annex A: electrical measurement laboratories;
- b) Annex B: mechanical measurement laboratories;
- c) Annex C: mass measurement laboratories.

### 5.2 Noise and vibration

Measurements and the laboratory personnel can be adversely affected by ambient noise and vibration from the laboratory building and from adjacent buildings, machinery, nearby roads carrying heavy vehicles, railways and other local industrial activities.

Ideally, the site for the laboratory should be free from such influences, particularly in the case of laboratories making acoustic, optical and mass measurements. If noise and vibration are likely to affect the measurement results, a survey of the site should be carried out to establish both the levels and frequencies of the ambient noise and vibration. If excessive noise and/or vibration are found, consideration should be given to a more suitable location for the laboratory.