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Engineering drawing practice —

Part 2: Recommendations for dimensioning and tolerancing of size

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- British Standards Society
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- Drawing Office Material Manufacturers' and Dealers' Association
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Foreword

This revision of BS 308-2 has been prepared under the direction of the General Mechanical Engineering Standards Committee; it reflects the established conventions and also takes account of both national and international developments since the 1972 revision, which is now withdrawn.

The proven record of standards applied to engineering drawing now enables its recognition as the graphical language of communication in engineering both nationally and internationally. Drawings made to the accepted standards in one country, when based on standards published by the International Organization for Standardization (ISO), are understood and can be used around the world in virtually all countries. With this in mind it was recognized and accepted to be important as a policy for this revision that particular attention and care should be paid to the quality of content of both text and figures to ensure their clarity and ease of understanding.

The UK continues to participate actively in ISO Technical Committees on technical drawing for the establishment of international published standards and much of the contents of this standard reflects those agreements reached internationally with which the UK has concurred. Some notes appear in this standard to draw attention to occasional divergence of practice. Appendix A provides information on aspects of engineering drawing practice covered by British and international standards.

The recommendations of this standard have been established having regard to the requirements of microfilming. Drawings prepared in accordance with this standard should be suitable for microfilming and reduced-size reproduction techniques.

During the course of this revision particular attention has been paid to developments in computer aided machine draughting and it has been established that such machines are currently capable of complying with this standard. Any minor exceptions due to the limitations of a particular system would not be expected to prejudice the understanding of a drawing otherwise claimed to comply with this standard.

The 1972 revision was coincidentally undertaken during the main period of transition of UK industry to the metric system and a limited recognition of the imperial system of units was included but this has not been retained in the present revision.

In the ISO committee for technical drawing it is the intention to unify, in one set of standards, the practices and conventions of all disciplines using technical drawings and their standards currently attempt to reflect that policy. In the UK the traditional separations are maintained and it should be carefully noted that BS 308 continues to provide recommendations for engineering drawings in the manufacturing industries associated with mechanical, electrical, electronics, hydraulics, pneumatics and nuclear engineering disciplines, as previously.

The requirements of the building, architectural, civil and structural engineering and construction services industries continue to be covered by BS 1192. BS 308 does not cover special disciplines such as in naval architecture and aeronautical lofting. There are standards published for some industries using BS 308 as a basis but requiring additional recommendations and conventions particular to the discipline. BS 4301, which gives recommendations for the preparation of drawings for optical elements and systems, and BS 2774, which gives drawing conventions for laboratory glassware, are examples.

BS 5070, dealing with engineering diagram drawing practice, is a companion standard to BS 308 and caters for the same industries, providing recommendations on a wide variety of engineering diagrams. Commonly, as a diagram can be called a “drawing” and a drawing can be called a “diagram”, it is useful to summarize the difference in the scopes of these standards. BS 308 covers what are commonly accepted to be drawings that define shape, size and form. BS 5070 covers the drawing of diagrams that are normally associated with flow of one sort or another and which relate components (usually indicated by symbols) functionally one to another by the use of lines, but do not depict their shape, size or form; neither do they in general indicate actual connections or locations.

For convenience of use, this revision of BS 308 follows the precedent established in 1972 of publishing in three Parts.

This Part leads on from Part 1, which deals with general principles, and continues the development of the drawing with the application of dimensions and tolerances and other related information on size and finish. It also covers interpretations and tolerancing principles.

The recommendations are generally in accordance with the following international standards.

ISO 129-1985, *Engineering drawing — Dimensioning*.

ISO 406-1982, *Technical drawings — Linear and angular tolerancing — Indications on drawings*.

ISO 1302-1978, *Technical drawings — Method of indicating surface texture on drawings*.

BS 308-3 deals specifically with geometrical tolerancing.

Particular attention is drawn to the revision of the clause on interpretation of limits of size (clause 9 of BS 308-2:1972). This now appears as clause 11 where, together with a clarification of the traditional interpretation, a new tolerancing concept has been introduced, in which specified dimensional and geometrical requirements are met independently (see 11.3). This principle of independency, as it is known, has been developed internationally and is the subject of ISO 8015 in the drafting of which the UK has collaborated. It is to be noted however that, whereas ISO 8015 will essentially specify the new concept with only concessionary reference to the commonly accepted relationship between tolerances of size and form, the BSI drafting committee has deemed it necessary that BS 308 presents both concepts with equal status.

Notes on the presentation of this standard

NOTE 1 The figures in this standard are independent and each is selected solely for its simplicity and clarity to illustrate only the text to which it relates. They are not the only possible examples and they are not intended as design examples or to be fully dimensioned working drawings but otherwise are drawn according to the basic recommendations of this standard.

NOTE 2 Linear dimensions shown in the figures are in millimetres.

NOTE 3 Numerical values of dimensions and tolerances given in the figures throughout are arbitrarily chosen to assist in illustrating the point under consideration; they are typical and are not given as recommendations.

NOTE 4 In the illustrations to this standard, a convention is adopted of using capital letters for notes that would appear as part of the drawing and lower case letters are used for notes explaining the point under consideration in relation to the text.

NOTE 5 This standard recognizes both the first and third angle projection methods as having equal status, see clause 7 of BS 308-1:1984, as does ISO 128-1982. The first angle projection method is that normally used for British Standards and is thus used in this publication in the interests of uniformity of presentation. The third angle method is only shown where it illustrates the relevant clause. However, it should be understood that the alternative projection method, i.e. third angle projection, could equally well have been used without prejudice to the principles established.

NOTE 6 Due to the limitations of size of the figures in this standard, the sizes of arrowheads may not conform to the recommendations of 5.4 in BS 308-1:1984.

This Part of BS 308 is being superseded by the adoption of European implementations of international standards.

The following standard has been published as a British Standard.

European standard	Subject	Deleting action on BS 308-2
BS EN ISO 3040 ^a	Cones	Clause 10
^a Delayed		

The following ISO standards are in the process of adoption, BS EN ISO 1660 has passed the formal vote stage.

ISO standard	Subject	Deleting action on BS 308-2
ISO 1302	Surface texture	Clause 13
ISO 1660	Dimensioning and tolerancing of profiles	Clause 7.3
ISO 8015	Tolerancing principle and interpretation of limits of size for control of form	Clause 11

Further ISO standards expected to be adopted include the following standards.

ISO standard	Subject	Deleting action on BS 308-2
ISO 129	Dimensioning	Clause 3, 4, 5, 6 7
ISO 406	Tolerancing, general	Clause 8
ISO 10209-3	Dimensioning and tolerancing terms	—

Because BS 308 does not conflict in its technical recommendations the withdrawal of this Part of the standard is delayed until all the relevant ISO standards have been adopted.

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 to vi, pages 1 to 50, 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 Part of BS 308 gives recommendations for the general principles of dimensioning and tolerancing and the methods of applying dimensions and tolerances of size on all engineering drawings.¹⁾

Recommendations are given for the application of machining and surface texture instructions. Guidance is given on the interpretation of limits of size and toleranced centre distances.

NOTE The titles of the publications referred to in this standard are listed on page 50.

2 Definitions

For the purposes of this Part of BS 308, the following definitions apply.

2.1 feature

an elemental part of an object, such as a plane, a cylindrical surface, an axis, a profile. (For feature-of-size, see clause 11)

2.2 functional feature

a feature that is essential to the performance or serviceability of the object of which it is a part. It may be a location feature (e.g. a spigot which serves to locate a component in an assembly) or a working surface (e.g. a bore of a bearing)

2.3 dimension

a numerical value, expressed in appropriate units of measurement, that defines a feature. Dimensions may be accompanied by lines, symbols and notes so that the features of an object will be completely defined

2.4 functional dimension

a dimension that is essential to the function of an object or space (see Figure 1)

2.5 non-functional dimension

a dimension that is not essential to the function of an object or space (see Figure 1)

2.6 auxiliary dimension

a dimension given for information only. It is shown within parentheses without tolerance and does not govern the acceptance of a product (see 5.3.4)

2.7 tolerance

the total amount of variation permitted for the size of a dimension, a positional relationship or the form of a profile or other design requirement

2.8 datum

a theoretically exact geometric reference such as an axis, plane, straight line, etc., to which toleranced features are related

2.9 actual local size

an actual two-point measurement of a dimensioned feature

3 Principles of dimensioning

3.1 Application

3.1.1 All dimensions, tolerances and information necessary for the complete description and function of an object should be expressed directly on a drawing and appear once only. Any departure from this principle should be limited to special cases and be the subject of an explanatory note.

3.1.2 The dimensions should relate to the condition in which the object, part or product is to be used and include any specified surface treatment or finishing other than painting or lacquering.

3.1.3 The drawing may define the item as ready for assembly or service, or as the product of a foundry, forge, etc., supplied for further processing.

3.1.4 Dimensions should be placed on that view or section which shows the relevant features most clearly.

3.1.5 Preferred sizes should be used wherever practical, e.g. holes, thread forms and fastener sizes, pins and standard material sizes.

3.1.6 All linear dimensions should be expressed in the same unit, e.g. millimetres (unit symbol “mm”). The unit symbol may be omitted provided the drawing carries a statement of the unit used.

When other units are required, the respective unit symbol should be shown with the value.

3.1.7 Dimensions should be expressed to the least number of significant figures (e.g. 35 not 35.0). See clause 8 for the expression of toleranced dimensions.

¹⁾ Civil and structural engineering and construction services drawings are excluded (see BS 1192). The special discipline aspects of naval architecture and aeronautical lofting are not included.

3.1.8 The decimal marker is a point which should be bold, given a full letter space and be placed on the baseline. It is recommended that where there are more than four figures to the right or left of the decimal marker a full space should divide each group of three figures counting from the position of the decimal marker, e.g. 12 500.

NOTE In many countries, the comma is used as the decimal marker.

3.1.9 Dimensions of less than unity should be preceded by the cipher "0", e.g. 0.25.

3.1.10 Angular dimensions on engineering drawings should be expressed either in degrees, minutes and seconds or in degrees and decimals of a degree, for example:

22°	22.5°
22° 30'	22.55°
22° 30' 30"	0.25°

A full space should be left between the degrees symbol and the minute figure, and between the minute symbol and the seconds figure. Angular dimensions expressed in degrees, minutes and seconds but of less than unity should be preceded by the cipher "0" and a degree and/or minute symbol as appropriate, e.g. 0° 15', 0° 0' 30".

NOTE The radian is the International System of Units (SI) unit for angular measurement but is not normally used on engineering drawings.

3.1.11 The practice of dual dimensioning (e.g. millimetres and inches) is deprecated but, if it is considered necessary to quote a conversion, the dimension to which the part is to be made and inspected should be shown first, with the conversion shown in parentheses.

3.2 Limitations

3.2.1 No more dimensions should be given than are necessary to describe the object, thus no feature should be located by more than one toleranced dimension in any one direction.

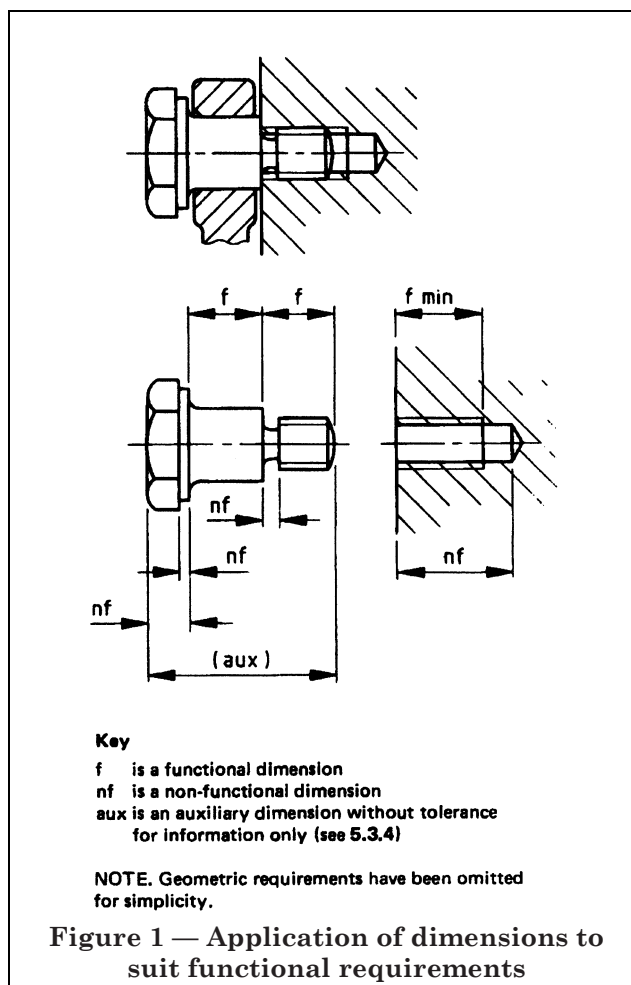
Exceptions may, however, be made in special cases where it is necessary to give dimensions which apply at intermediate stages of manufacture (e.g. for the size of a feature before carburizing and finishing to size).

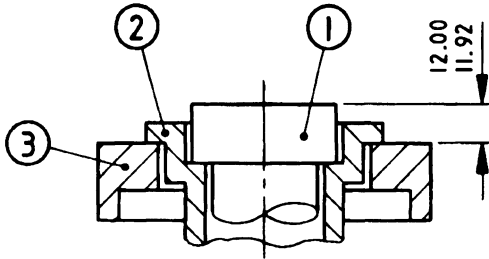
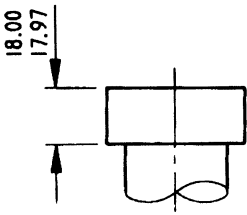
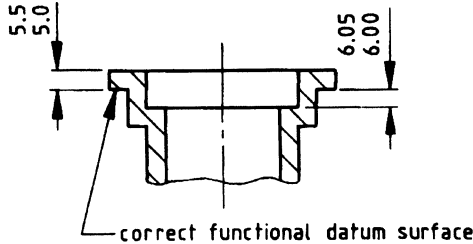
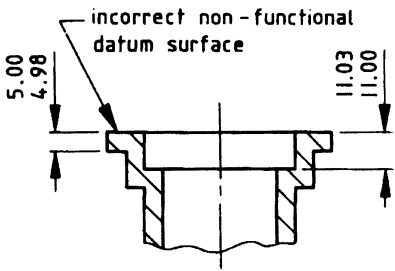
3.2.2 Production processes or inspection methods should not be specified unless they are essential to ensure satisfactory functioning or interchangeability.

3.3 Functional dimensioning

3.3.1 The functional dimensions should be expressed directly on the drawing (see Figure 1). The application of this principle will result in the selection of datum features on the basis of the function of the product and the method of locating it in any assembly of which it may form a part. If any datum feature other than one based on the function of the product is used, finer tolerances will be necessary and products which would satisfy the functional requirements may be rejected because they exceed these finer tolerances (see Figure 2).

This recommendation does not preclude the preparation of special drawings, wholly dimensioned from a common datum point, to suit particular numerically controlled machining systems where it is known that the overall accuracy of the system to be used will be adequate to ensure that the finer tolerances, arising from dimensioning other than directly from functional datum features, are met.



Description	Drawing
a) Assembly drawing showing a given functional requirement, namely the limits of height of the top face of item 1 above the top face of item 3, with a tolerance of 0.08 mm	
b) Detail of head of item 1 showing given limits of size, with a tolerance of 0.03 mm	
c) Item 2 dimensioned from a functional datum surface NOTE One direct dimension with a tolerance of 0.05 mm is needed to satisfy the condition shown in a). A nominal flange thickness of 5 mm has been assumed. This value is non-functional and can have any large tolerance.	 correct functional datum surface
d) Item 2 dimensioned from a non-functional datum surface NOTE Tolerances have had to be reduced; two dimensions with tolerances of, say, 0.02 mm for the flange and 0.03 mm are now needed to satisfy the condition shown in a).	 incorrect non-functional datum surface
NOTE Geometric requirements have been omitted for simplicity. Figure 2 — Effect of changing datum surfaces from those determined by functional requirements	

3.3.2 The arrangement of non-functional dimensions may be chosen to aid production or inspection.

3.3.3 A dimension is not complete without a tolerance although the tolerance may not always appear with the dimension.

4 Method of application (general conventions)

4.1 Terms for elements of dimensioning

The elements of dimensioning are shown in Figure 3.

4.2 Projection lines and dimension lines

4.2.1 The use of projection lines and dimension lines is shown in Figure 3.

4.2.2 Projection lines and dimension lines should normally be placed outside the outline of the view and are thin continuous lines of type B, as defined in Table 2 of BS 308-1:1984.

4.2.3 Intersection of dimension lines and projection lines should be avoided but, where intersection is unavoidable, they are generally shown without a break. Breaks are only introduced for clarity and then only in the projection lines.

NOTE In this context, outlines are never broken.

4.2.4 Projection lines should start just clear of the outline of the feature and should extend a little beyond the dimension line (see Figure 3)²⁾

4.2.5 Where projection lines refer to points on surfaces or to imaginary points of intersection, they should touch or pass through the points, as shown in Figure 4(a) and 4(b). To gain clarity, the points may be emphasized by a small dot, as in Figure 4(b).

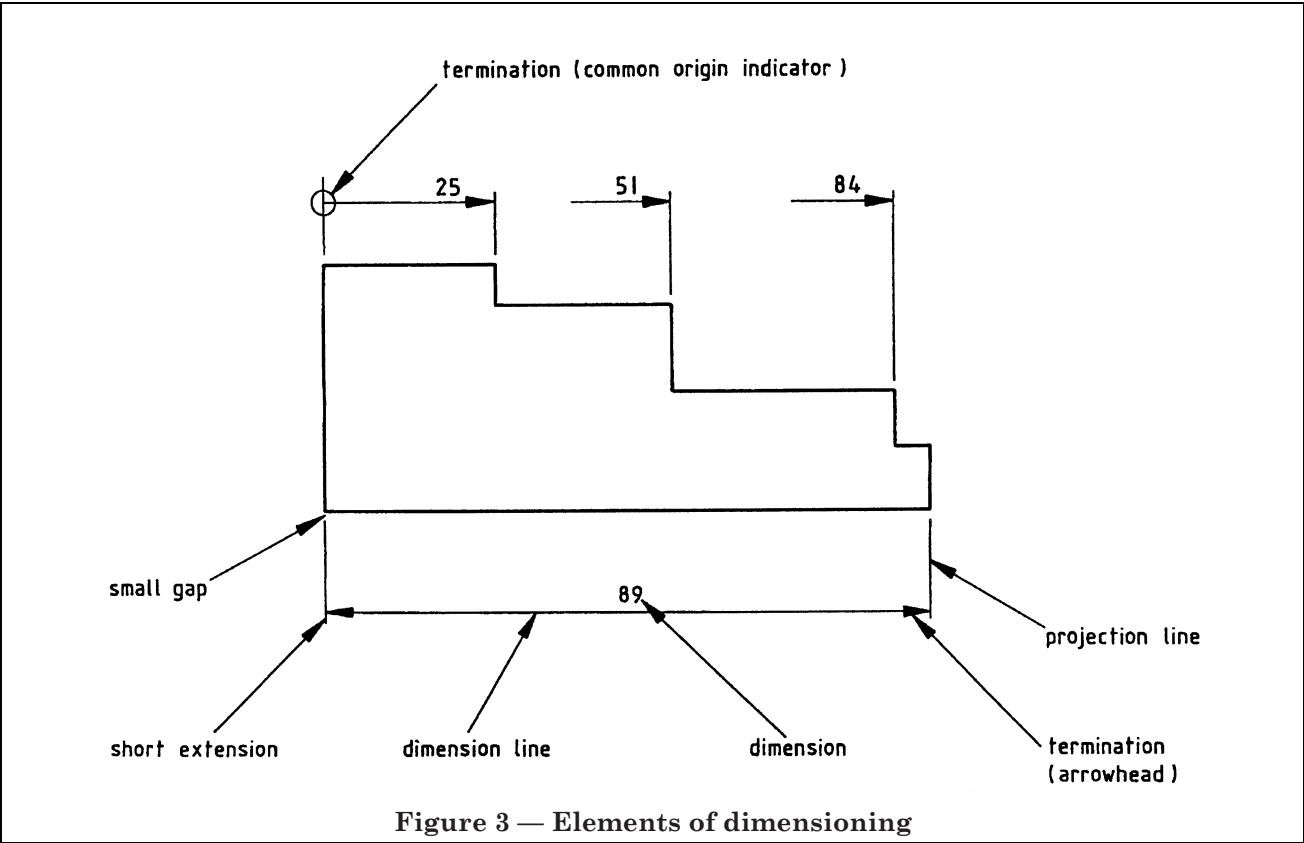


Figure 3 — Elements of dimensioning

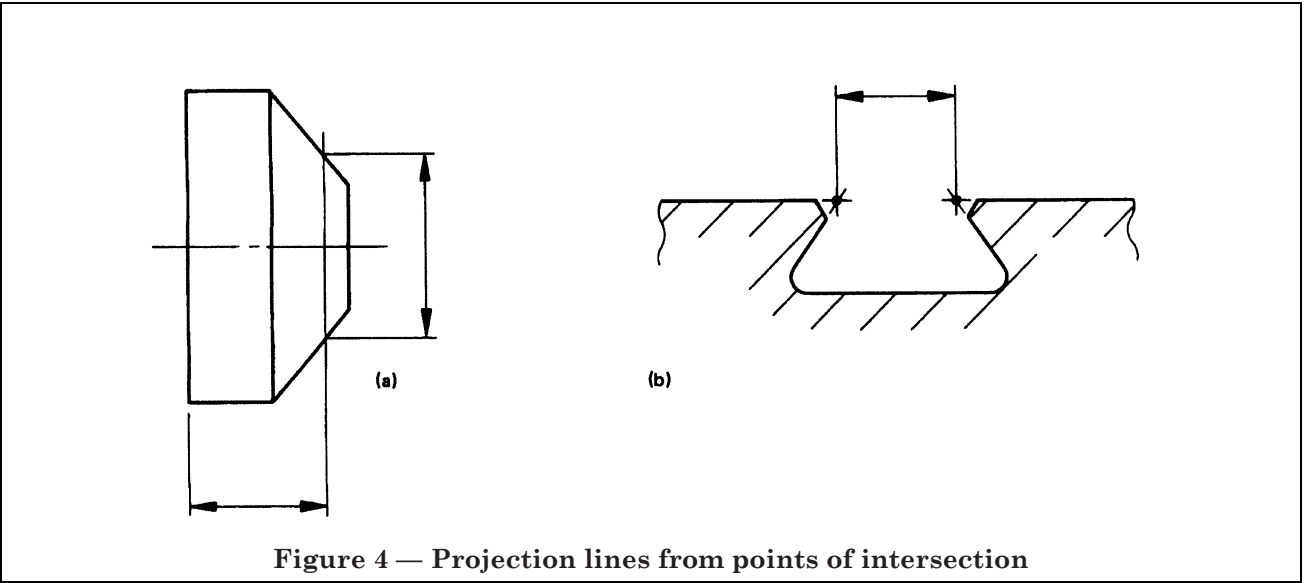


Figure 4 — Projection lines from points of intersection

²⁾ ISO 129 does not show projection lines starting clear of the outline.

4.2.6 Projection lines should normally be drawn perpendicular to the dimension required (see Figure 5).

In certain circumstances, for example on tapers, better clarity is achieved by drawing the projection lines obliquely (see Figure 6).

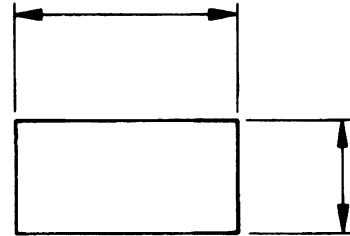


Figure 5 — Projection lines perpendicular to required dimensions

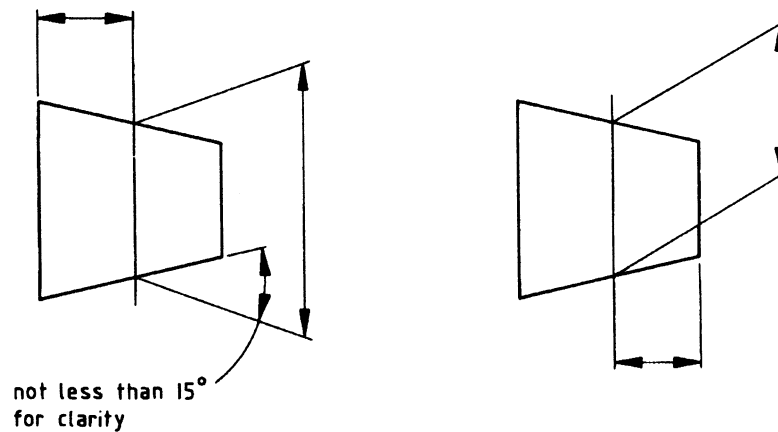


Figure 6 — Projection lines oblique to feature

4.2.7 Projection lines and dimension lines for chords, arcs and angles should be as shown in Figure 7, Figure 8³⁾ and Figure 9, respectively.

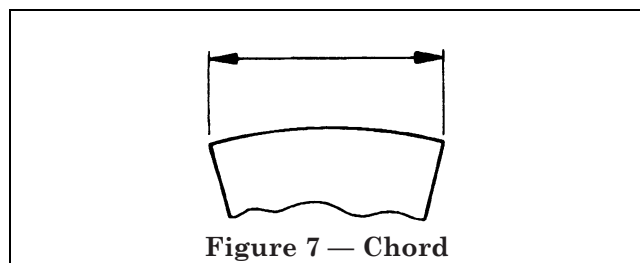


Figure 7 — Chord

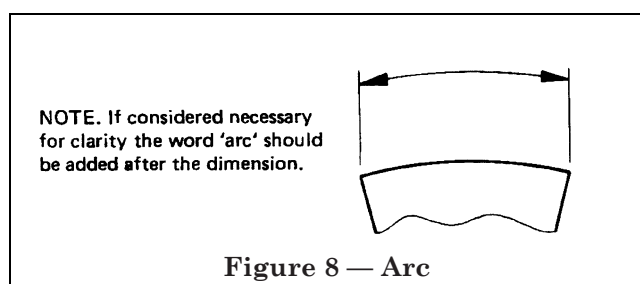


Figure 8 — Arc

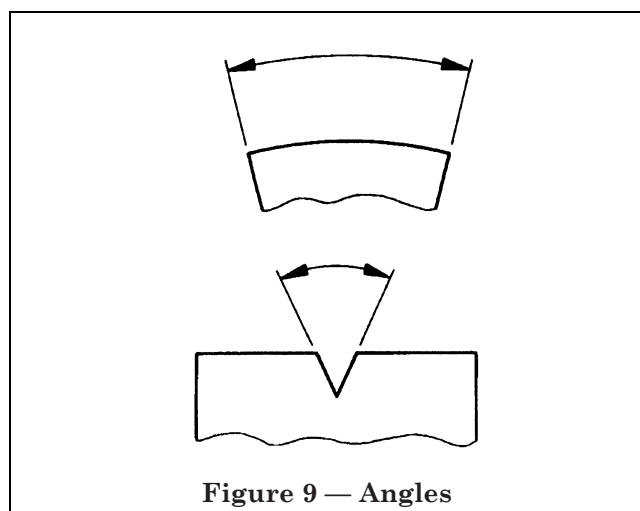


Figure 9 — Angles

4.2.8 Centre lines, extensions of centre lines and projected continuations of outlines should never be used as dimension lines. Dimension lines should generally be placed with their terminations at projection lines and not at outlines.

4.2.9 Dimension lines should be drawn unbroken where the feature they refer to is shown interrupted (see Figure 10).

4.2.10 When symmetrical parts are drawn partially, the portions of the dimension lines should extend a short distance beyond the axis of symmetry and the second terminations are omitted, as shown in Figure 11.

4.3 Terminations

4.3.1 Arrowheads and common origin circles are used as terminations on dimension lines. The use of the common origin circle is described in 6.2 and 6.5. The common origin circle should be not less than 3 mm in diameter and is drawn as a type B line (see Table 2 of BS 308-1:1984).

4.3.2 Arrowheads are drawn within the limits of the dimension line where space is available (see dimensions 12 mm and 14 mm in Figure 12). Where space is limited, the methods used in Figure 12 for dimensions 3 mm and 2 mm should be adopted⁴⁾.

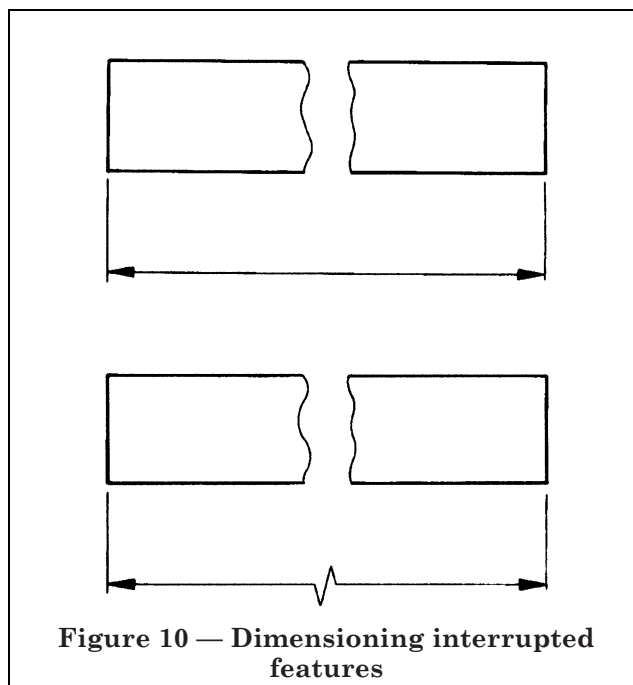


Figure 10 — Dimensioning interrupted features

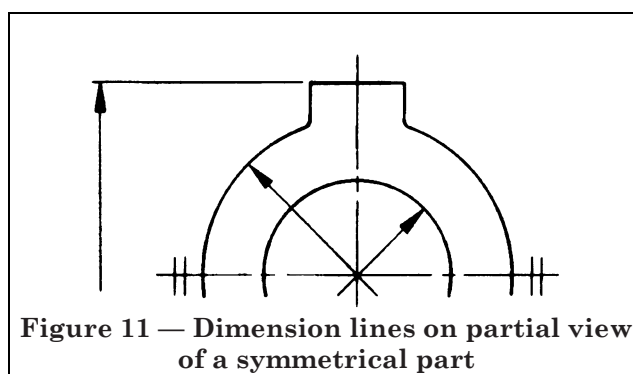


Figure 11 — Dimension lines on partial view of a symmetrical part

³⁾ ISO 129 requires a small arc to be shown over the dimension.

⁴⁾ In some countries, and in ISO 129, the dimension line is continued through the space.

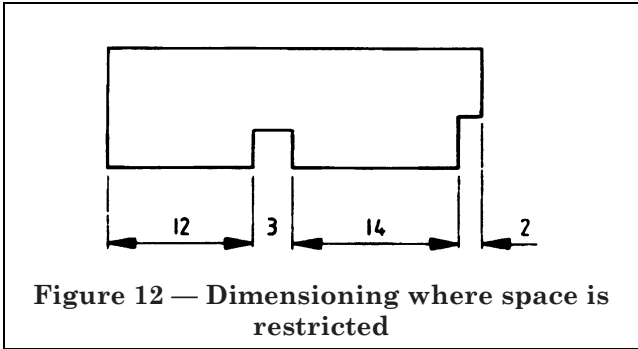


Figure 12 — Dimensioning where space is restricted

4.3.3 Oblique strokes may be substituted for arrowheads where there are severe space limitations (see Figure 13). The oblique stroke is drawn at an angle of 45° to the dimension line through its point of intersection with the projection line using a type B line (see Table 2 of BS 308-1:1984). The stroke should be 3 mm to 8 mm long.

5 Arrangement of dimensions and application of values

5.1 Application of values

Dimensions should be shown on drawings in characters of sufficient size to ensure complete legibility on any copies as well as on the original drawing. For details of minimum character height see 6.3 of BS 308-1:1984.

5.2 Use of letters and symbols

The following letters and symbols should be used with dimensions to identify the shape of a dimensioned feature. The letter or symbol precedes the dimension. The letters and symbols should be as large as the associated numerals (see Figure 14).

- | | | | |
|---|---------------------|----|--------------------|
| Ø | diameter | SØ | spherical diameter |
| R | radius | SR | spherical radius |
| ⊠ | square ^a | | |

^a ISO 129 shows a square without an inscribed diagonal cross.

NOTE 1 The oblique through the diameter symbol should approximate to 30° from the vertical as read.

NOTE 2 A general list of recommended abbreviations and symbols is given in BS 308-1.

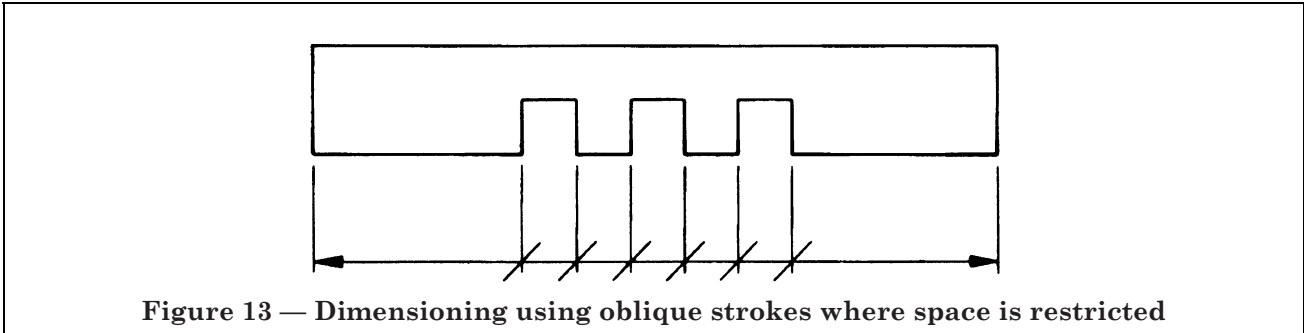


Figure 13 — Dimensioning using oblique strokes where space is restricted

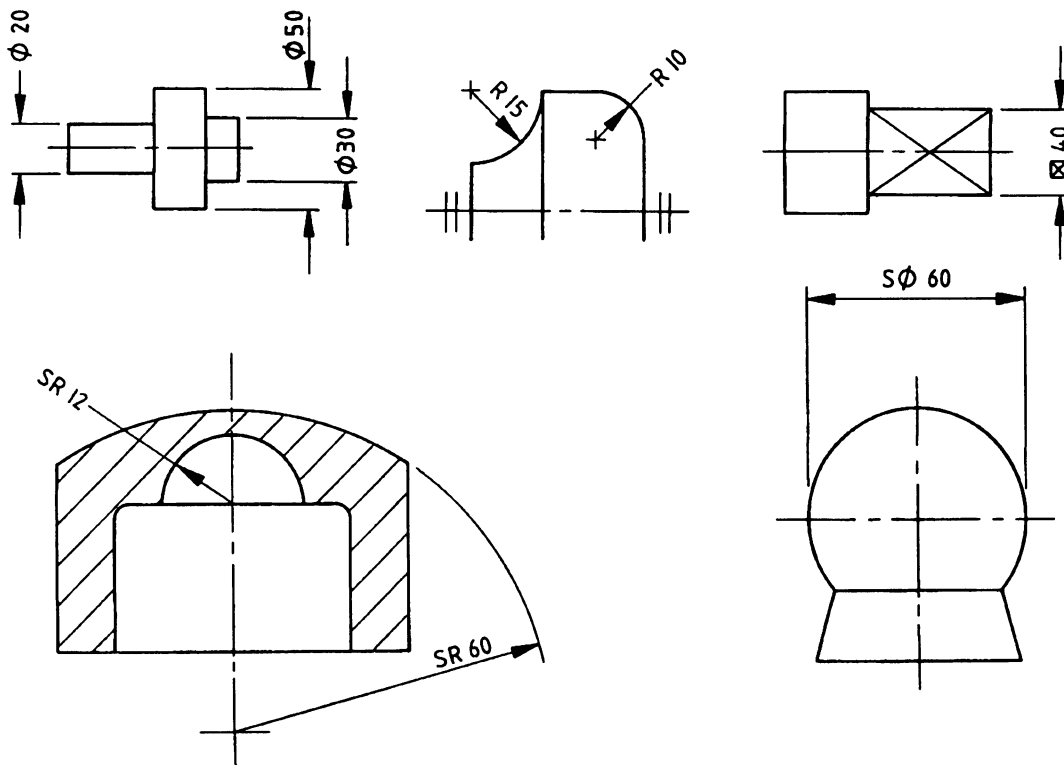


Figure 14 — Use of letters and symbols with dimensions

5.3 Arrangement of dimensions

5.3.1 General. Dimensions should be arranged so that the direction of reading is from the bottom of the drawing or from the right-hand side of the drawing, as shown in Figure 15 and Figure 16. Dimensions should preferably be placed outside the zones shown hatched in Figure 15.

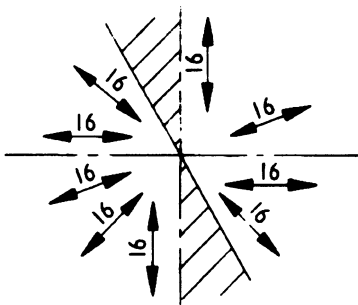


Figure 15 — Orientation of linear dimensions

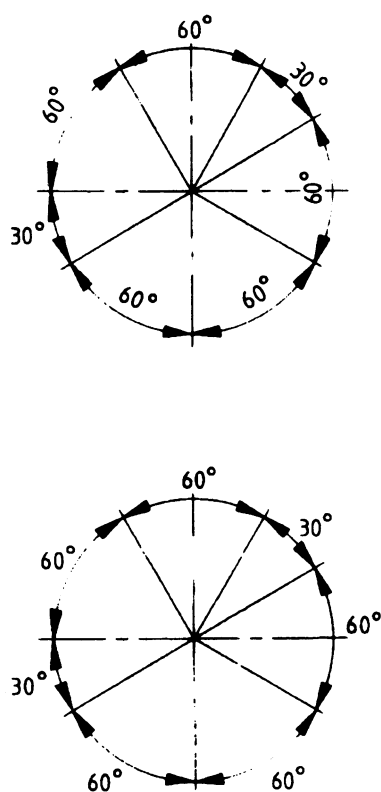


Figure 16 — Orientation of angular dimensions

5.3.2 Placing of dimensions

5.3.2.1 Generally, dimensions should be placed near the middle of, slightly above and clear of the dimension line (see Figure 17).

5.3.2.2 To avoid dimensions being crossed by other lines they may be placed closer to one termination (see Figure 18).

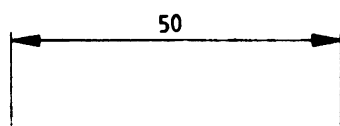


Figure 17 — Position of dimensions

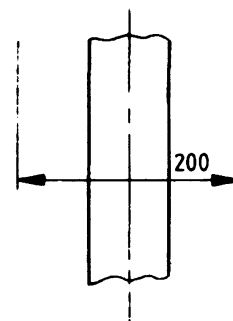


Figure 18 — Offset dimension

5.3.2.3 When there are several parallel dimension lines in proximity, the dimensions may be staggered, as in Figure 19(a) and 19(b), to avoid superimposing figures or having to follow a long dimension line. In some cases, dimension lines may be shortened, as in Figure 19(b).

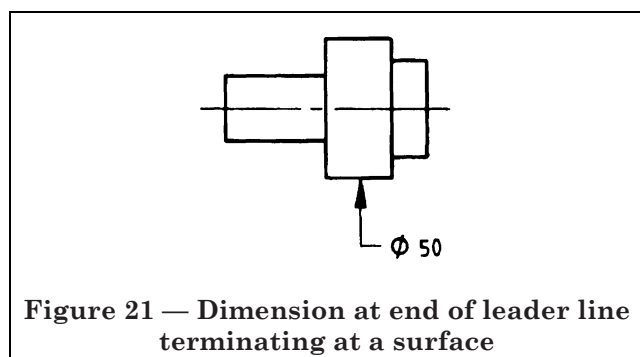
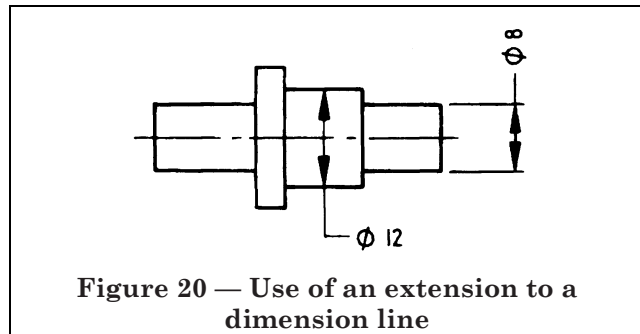
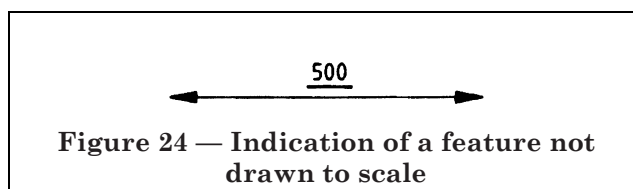
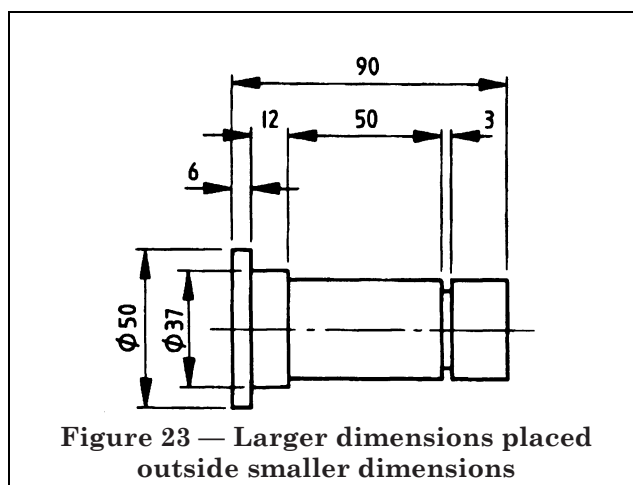
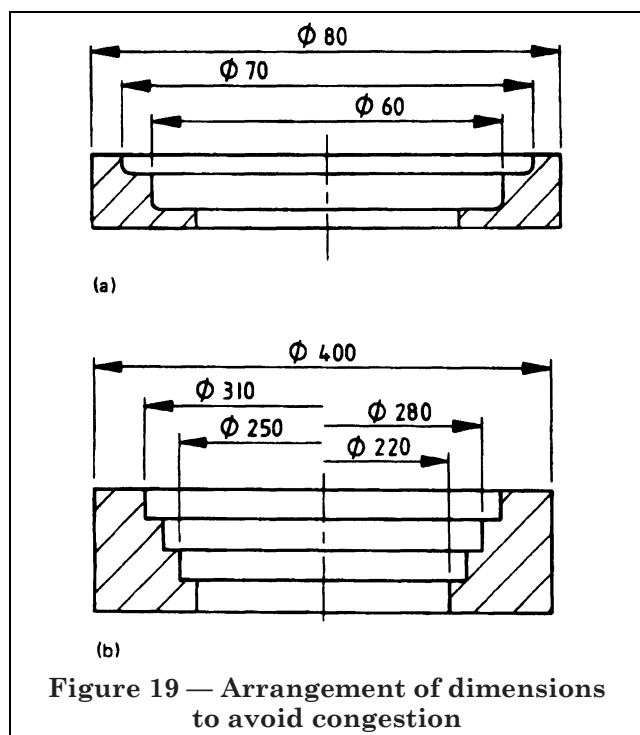
5.3.2.4 Dimensions may be placed at the end of a leader line, the opposite end of which terminates on a dimension line or its extension, as in Figure 20, or on a surface, as in Figure 21 (see also 7.1.2).

5.3.2.5 Where there is limited space for dimensioning, the dimension should be placed centrally or above, or in line with, the extension of one of the dimension lines (see Figure 22).

5.3.2.6 Larger dimensions should be placed outside smaller dimensions, as in Figure 23.

NOTE to 5.3.2. For superimposed dimensioning, see 6.2.2 and 6.5.1.

5.3.3 Features not drawn to scale. Where it is necessary to indicate that a feature is not drawn to scale, it should have its dimension underlined, as in Figure 24.



5.3.4 Auxiliary dimensions. Where an overall dimension is shown, one of the intermediate dimensions would be redundant and therefore would not be shown, as in Figure 23. Exceptions may be made where redundant dimensions would provide useful information; in these cases they should be given as auxiliary dimensions. Where all the intermediate dimensions are necessary, the overall length can be given as an auxiliary dimension (see 2.6 and Figure 25). A further application is shown in Figure 26.

