BS 1916-1:2009

BSI British Standards

Limits and fits for engineering

Part 1: Guide to limits and tolerances

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British Standards

Publishing and copyright information

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Date	Text affected

Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i to ii, pages 1 to 32, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI and came into effect on 30 September 2009. It was prepared by Technical Committee TDW/4, *Technical product realization*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 1916-1:1953, which is withdrawn.

Relationship with other publications

This British Standard is published in three parts:

Part 1 – Guide to limits and tolerances;

Part 2 – Guide to the selection of fits in BS 1916-1;

Part 3 – Guide to tolerances, limits and fits for large diameters.

The ISO 286 (BS EN 20286) series establishes the ISO code-system for tolerances of linear sizes and is published in the following parts:

ISO 286-1 (BS EN 20286-1), *ISO system of limits and fits – Part 1: Bases of tolerances, deviations and fits;*

ISO 286-2 (BS EN 20286-2), *ISO system of limits and fits – Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts.*

The ISO 286 series covers the metric system of limits and fits; the BS 1916 series provides guidance and recommendations on the equivalent inch system (imperial).

Information about this document

In view of the time elapsed since its original publication in 1953, this British Standard was reviewed in detail in 2009. It was decided that the technical provisions of the previous edition were still generally applicable, but the figures have been redrawn for ease of use, the wording of some guidance updated for clarity, and the opportunity was taken to update references to other standards.

Use of this document

As a guide, this part of BS 1916 takes the form of guidance and recommendations. It should not be quoted as if it were a specification or a code of practice and claims of compliance cannot be made to it.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This part of BS 1916 gives guidance on tolerances, limits and fits for engineering sizes up to 19.69 in. The recommendations apply particularly to fits between cylindrical parts, designated as "holes" and "shafts", in which case the term "size" refers to the diameter of the mating parts. The data may also be applied in appropriate cases, by suitable selection of the grades of allowance and tolerances, to fits between other than cylindrical mating parts, in which case the "size" refers to a length, width or other dimension instead of to a diameter.

The system described in this British Standard comprises suitable combinations of 16 grades of tolerance and 21 types of fit for both hole and shaft, ranging from fits of extreme interference to those of extreme clearance. All but very exceptional engineering requirements are covered, from very coarse work to fine gauge manufacture.

A selection of fits for general use is given in Figure 4, and further guidance on tolerances for shafts and holes for a wide range of fits is given in Part 2 of this British Standard, but it is intended that a particular industry or organization extracts and uses those limits which suit its own product. A unilateral hole basis system is recommended but a full range of holes suitable for use on a shaft basis system, unilateral or bilateral, is also included in the tables.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 969*, Specification for limits and tolerances on plain limit gauges*

BS 8888*, Technical product specification – Specification*

3 Terms and definitions

For the purposes of this part of BS 1916, the following terms and definitions apply.

NOTE The basic terms used in this standard are illustrated in Figure 1.

3.1 fundamental tolerances

sixteen grades of tolerance for each size range on which the system is based

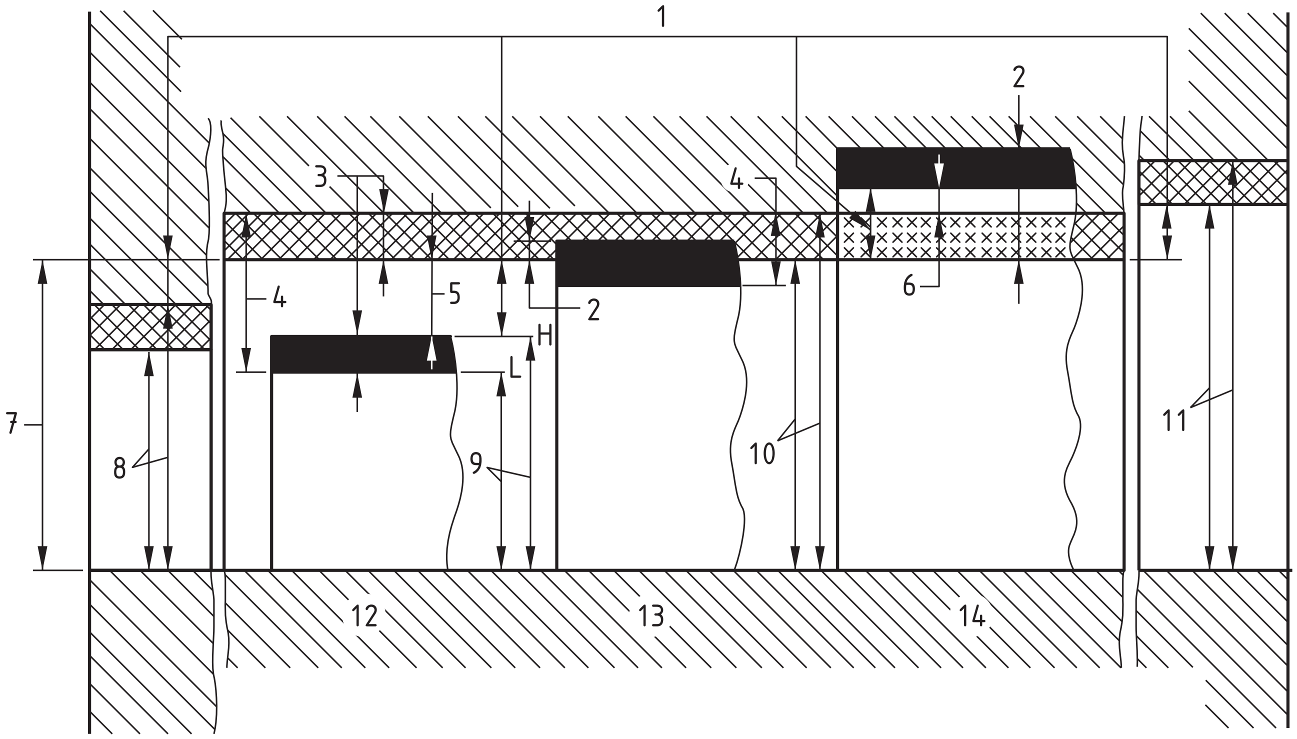
*NOTE See Clause **6** and Table 1.*

3.2 deviations

algebraic amounts by which the limits of size are greater (+) or less (–) than the nominal size

NOTE The deviations for the basic member of a mating pair are identical with the limits of tolerance for that member. The difference between the deviations for each member is equal to the tolerance for that member.

Figure 1 **Diagram showing the disposition of limits and tolerances (Basic hole)**



Key

1	Fundamental deviation	6	Minimum interference	11	Oversize hole
2	Maximum interference (allowance)	7	Nominal size	12	Clearance
3	Tolerance	8	Undersize hole	13	Transition
4	Maximum clearance	9	Limits for size of shaft	14	Interference
5	Minimum clearance (allowance)	10	Limits for size of hole		

4 Basis of conversion

In order to obtain fit interchangeability between parts made to the metric system of limits and fits (see BS EN 20286) and to the equivalent inch system, the inch tolerance values have been obtained by direct conversion of the metric tolerance values (see Annex A), 1 in = 25.4 mm.

The tables were compiled as follows.

a) The fundamental tolerances (described as IT1 to IT16) are obtained by converting and rounding-off the metric values.

b) The fundamental deviations ("A" to "Z" for holes and "a" to "z" for shafts) are obtained by converting and rounding-off the metric values.

c) The final limits are obtained by adding the fundamental tolerances to, or subtracting them from, the fundamental deviations (see Clause **6**).

5 Diameter steps

The metric version (see BS EN 20286) uses diameter increments or steps based partly on Preferred Numbers (see BS 2045) and partly (in the sizes below 180 mm) on existing metric practice. In the translation these steps have all been retained and converted to convenient inch equivalents, rounding being to the nearest hundredth of an inch in the upward direction. This ensures that preferred design sizes do not fall between the exact equivalent and the rounded value.

The fine diameter steps are only used with some shafts and holes.

6 Explanation of the system

6.1 Fundamental tolerances

The system provides for 16 grades of tolerances for each size range, designated IT1 to IT16 (see Table 1).

NOTE The letters of the symbol "IT" stand for "International Tolerance" grade.

These are called "fundamental tolerances" and are multiples of the fundamental tolerance unit "i" where:

$$i\ (\text{microns}) = 0.45 \times \sqrt[3]{D} + 0.001 \times D \qquad (D \text{ in millimetres})$$

or

$$i\ (0.001\ \text{in}) = 0.052 \times \sqrt[3]{D} + 0.001 \times D \qquad (D \text{ in inches})$$

where "D" is the geometric mean of the diameter steps involved.

The tolerances of Grade IT6 are 10 i. The values IT7, IT8, etc. are 16 i, 25 i, etc., in a progression based on the five-series Preferred Numbers; IT12 is therefore ten times IT7, IT13 ten times IT8, etc. Each tolerance grade is approximately 60% greater than its predecessor.

The values of IT5 are 0.7 times the values of IT6; the values of IT1 are, however, arranged to suit gauge requirements, and the others, IT2 to IT4, in regular but arbitrary progression between IT1 and IT5.

6.2 Fundamental deviations

The tolerance determines the dimensional difference between two limits, but to establish the various fits, one of the limits should be determined as required by the design requirement, the other obtained by adding or subtracting the fundamental tolerance. The derivation of the various fundamental deviations is given in Annex B.

The positions of the tolerance zone boundaries nearest the zero line, i.e. fundamental deviations, are indicated by 21 letters, using capitals for holes and small letters for shafts, as follows.

For holes: A B C D E F G H J K M N P R S T U V X Y Z

For shafts: a b c d e f g h j k m n p r s t u v x y z

As shown in Figure 2 and Figure 3, the letters "A" to "H" and "k" to "z" inclusive apply to the tolerance zones above the reference line, the letters "A" and "z" corresponding to the most distant. The letters "a" to "h" and "K" to "Z" inclusive apply to the tolerance zones below the reference line, the letters "a" and "Z" corresponding to the most distant.

The tolerance zones "H" lie on the plus side only of the reference line, the tolerance zones "h" on the minus side only, while the tolerance zones "J" and "j" lie on both sides of the reference line.

Although a free association of the various shafts and holes is possible, it is strongly recommended that the unilateral hole basis system be used ("H" is the standard hole). In the hole basis system, shafts "a" to "h" are provided for clearance fits and "j" to "z" for transition and interference fits.

Holes for use on a unilateral shaft basis system may also be selected with "h" as the standard shaft. In the shaft basis system, holes "A" to "H" are provided for clearance fits and "J" to "Z" for transition and interference fits.

Table 1 **Fundamental tolerances of grades 1 to 16**

Nominal diameters (in)	**For gauges**					**For fits**							**Large tolerances (not for fits)**			
	Tolerance grades															
	IT1	**IT2**	**IT3**	**IT4**	**IT5**	**IT6**	**IT7**	**IT8**	**IT9**	**IT10**	**IT11**	**IT12**	**IT13**	**IT14**	**IT15**	**IT16**
> 0.04 ⩽ 0.12	0.06	0.08	0.12	0.15	0.2	0.25	0.4	0.6	1.0	1.6	2.5	4.0	6.0	10.0	16.0	25.0
> 0.12 ⩽ 0.24	0.06	0.08	0.12	0.15	0.2	0.3	0.5	0.7	1.2	1.8	3.0	5.0	7.0	12.0	18.0	30.0
> 0.24 ⩽ 0.40	0.06	0.08	0.12	0.15	0.25	0.4	0.6	0.9	1.4	2.2	3.5	6.0	9.0	14.0	22.0	35.0
> 0.40 ⩽ 0.71	0.06	0.08	0.12	0.2	0.3	0.4	0.7	1.0	1.6	2.8	4.0	7.0	10.0	16.0	28.0	40.0
> 0.71 ⩽ 1.19	0.06	0.08	0.16	0.25	0.4	0.5	0.8	1.2	2.0	3.5	5.0	8.0	12.0	20.0	35.0	50.0
> 1.19 ⩽ 1.97	0.08	0.12	0.16	0.3	0.4	0.6	1.0	1.6	2.5	4.0	6.0	10.0	16.0	25.0	40.0	60.0
> 1.97 ⩽ 3.15	0.08	0.12	0.2	0.3	0.5	0.7	1.2	1.8	3.0	4.5	7.0	12.0	18.0	30.0	45.0	70.0
> 3.15 ⩽ 4.73	0.12	0.16	0.24	0.4	0.6	0.9	1.4	2.2	3.5	5.0	9.0	14.0	22.0	35.0	50.0	90.0
> 4.73 ⩽ 7.09	0.16	0.2	0.32	0.5	0.7	1.0	1.6	2.5	4.0	6.0	10.0	16.0	25.0	40.0	60.0	100.0
> 7.09 ⩽ 9.85	0.2	0.28	0.4	0.6	0.8	1.2	1.8	2.8	4.5	7.0	12.0	18.0	28.0	45.0	70.0	120.0
> 9.85 ⩽ 12.41	0.24	0.32	0.48	0.6	0.9	1.2	2.0	3.0	5.0	8.0	12.0	20.0	30.0	50.0	80.0	120.0
> 12.41 ⩽ 15.75	0.28	0.36	0.5	0.7	1.0	1.4	2.2	3.5	6.0	9.0	14.0	22.0	35.0	60.0	90.0	140.0
> 15.75 ⩽ 19.69	0.32	0.4	0.6	0.8	1.0	1.6	2.5	4.0	6.0	10.0	16.0	25.0	40.0	60.0	100.0	160.0

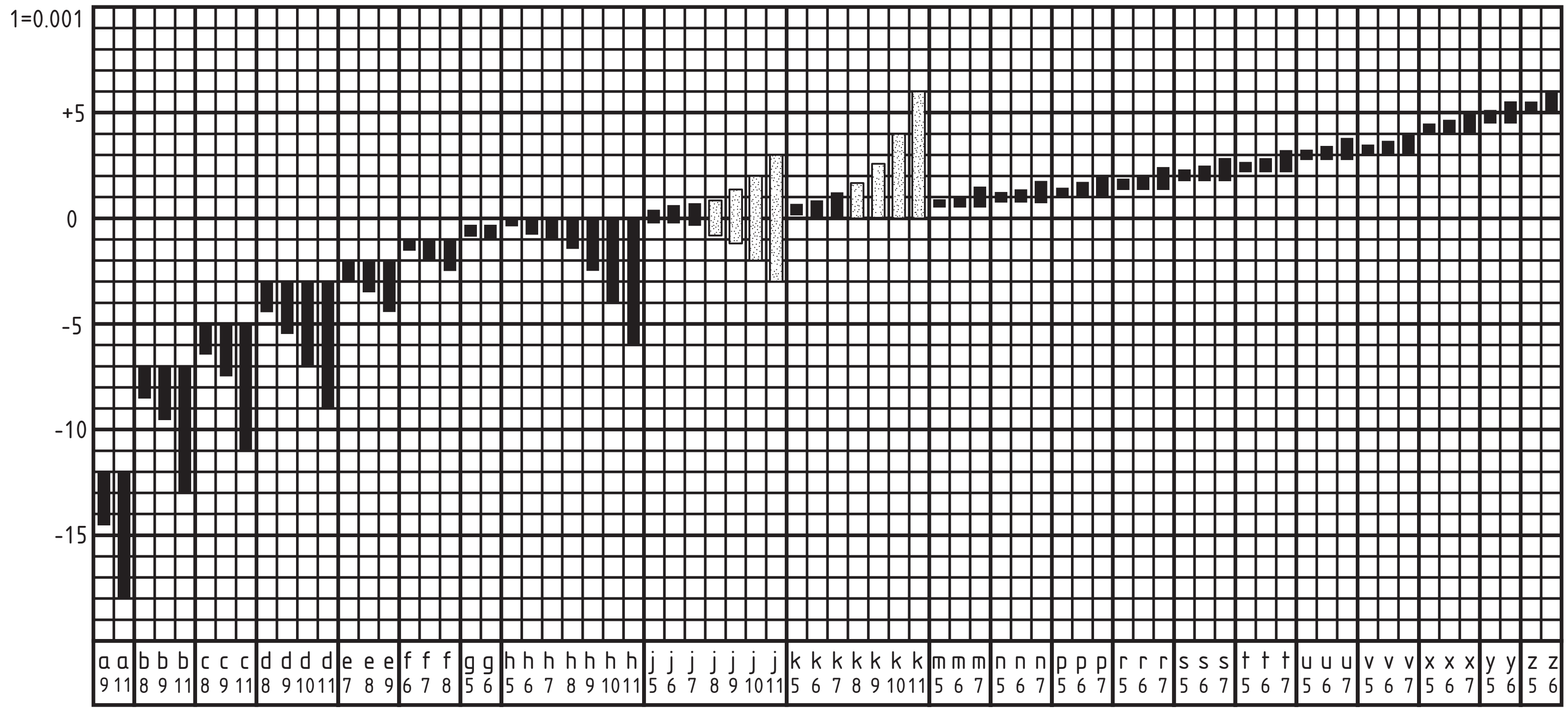
As shown in Figure 2 and Figure 3, the letters “A” to “H” and “k” to “z” inclusive apply to the tolerance zones above the reference line, the letters “A” and “z” corresponding to the most distant. The letters “a” to “h” and “K” to “Z” inclusive apply to the tolerance zones below the reference line, the letters “a” and “Z” corresponding to the most distant.

The tolerance zones “H” lie on the plus side only of the reference line, the tolerance zones “h” on the minus side only, while the tolerance zones “J” and “j” lie on both sides of the reference line.

Although a free association of the various shafts and holes is possible, it is strongly recommended that the unilateral hole basis system be used (“H” is the standard hole). In the hole basis system, shafts “a” to “h” are provided for clearance fits and “j” to “z” for transition and interference fits.

Holes for use on a unilateral shaft basis system may also be selected with “h” as the standard shaft. In the shaft basis system, holes “A” to “H” are provided for clearance fits and “J” to “Z” for transition and interference fits.

Figure 3 **Tolerance zones for shafts arranged according to symbol**



Not for fits

Diagram to scale for Ø 1.19 in to 1.97 in.

NOTE The shafts v, x, y and z are not to be considered as definite recommendations, but for trials. The shafts v and y are to be avoided as much as possible.

7 Terminology

A hole is described by the appropriate capital letter followed by a suffix number denoting the tolerance grade, e.g. H7.

A shaft is described by a small letter followed by a suffix number denoting the tolerance grade, e.g. p6.

A fit is described by the hole symbol followed by that of a shaft, e.g. H7–p6 or H7/p6.

It is recommended that on production drawings, the actual limits for both hole and shaft should be explicitly stated by one of the methods in BS 8888, so that the parts to be measured by measuring instruments indicating actual size can be manufactured without reference to this British Standard. There are, however, certain circumstances – for example, in general specifications, or on preliminary design drawings – in which it is convenient to be able to designate a particular type of fit by symbols only. In some workshops it is customary to use the symbolic notation on production drawings and for the identification of gauges, but where this is done, the symbols should be quoted in addition to the actual limits if any production requirements necessitate their use.

8 Selection of limits

A particular industry or organization should extract from the tables those limits which best suit its own products. Certain recommendations are made in Clause **9**. Part 2 of this British Standard gives recommendations on the limits and fits to be used for a wide range of applications.

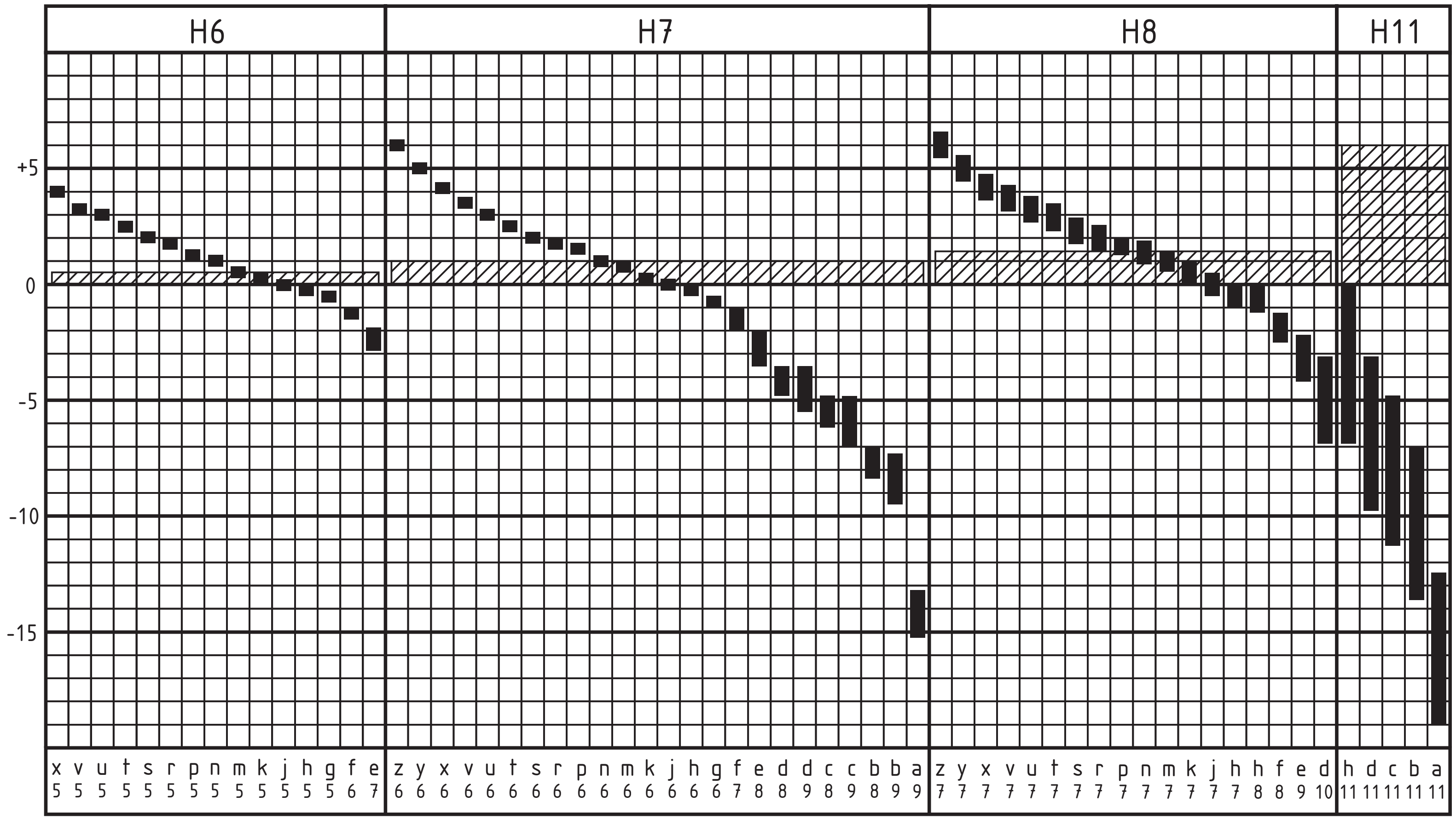
9 Initial selection for normal use

a) For ordinary engineering purposes, only a small number of the many possible fits is required. The full range of shaft fits recommended for use with the holes H6, H7, H8 and H11 is given in Figure 4. The following indicates those fits which will be found to meet many of the needs of the average engineering organization.
   - H8 – d10, e9, f8, h7, j7, k7, m7
   - H7 – e8, f7, g6, h6, k6, p6, s6
   - H6 – f6, g5, k5

b) Satisfactory clearance fits are obtained with the following combinations of holes and shafts.
   - H6 – g5, f6, e7
   - H7 – g6, f7, e8, d8/d9, c8/c9, b8/b9, a9
   - H8 – f8, e9, d10

c) Satisfactory interference fits are obtained with the following combinations of holes and shafts.
   - H6 – n5 to x5
   - H7 – p6 to z6
   - H8 – s7 to z7

Figure 4 **Recommended selection of fits for general engineering requirements, basic hole system**



Shafts

Holes

Diagram to scale for Ø 1.19 in to 1.97 in.

NOTE The shafts v, x, y and z are not to be considered as definite recommendations, but for trials. The shafts v and y are to be avoided as much as possible.

10 Gauge limits

Use should be made of gauge limits as specified in BS 969.

11 Equivalent fits

The following gives the equivalence of BS 1916 fits and the Newall system.

The actual dimensions in the systems are not interchangeable and the comparisons are not exact, particularly on larger sizes. Designers should check that particular cases are satisfactory.

a) Holes and shafts
   1) Holes H7 and H8 are equivalent to A and B respectively in the Newall system.
   2) Shafts f7 and e8 are equivalent to Y and X respectively in the Newall system.

b) Clearance fits
   1) H7–e8 = A.X in the Newall system.
   2) H7–f7 = A.Y in the Newall system.
   3) H8–g7 = A.Z in the Newall system.
   4) H7–h6 and H8–h7 = A.P in the Newall system.

   NOTE H8–g7 is a non-preferred association. H7–f7 or H8–f7 are suggested.

c) Transition fits

   There are no Newall equivalents.

d) Interference fits
   1) H7–s6 and H8–s7 are approximately equivalent to A.D and B.D in the Newall system.
   2) H7–x6 = A.F in the Newall system.

12 Limits for holes and shafts

Table 2 shows the limits for holes and Table 3 shows the limits for shafts. Both tables are in inch units. See Annex C for notes on these tables of limits.

Table 2 **Limits for holes (inch units)**
Tolerance unit = 0.001 inch

Nominal sizes		**A**			**B**				**C**			
(in)		**9**	**11**	**9, 11**	**8**	**9**	**11**	**8–11**	**8**	**9**	**11**	**8–11**
Over	**To**	**High** +	**High** +	**Low** +	**High** +	**High** +	**High** +	**Low** +	**High** +	**High** +	**High** +	**Low** +
0.04	0.12	11.0	12.5	10.0	5.6	6.0	7.5	5.0	3.1	3.5	5.0	2.5
0.12	0.24	11.2	13.0	10.0	5.7	6.2	8.0	5.0	3.5	4.0	5.8	2.8
0.24	0.40	11.4	13.5	10.0	6.9	7.4	9.5	6.0	3.9	4.4	6.5	3.0
0.40	0.56	13.6	16.0	12.0	7.0	7.6	10.0	6.0	4.5	5.1	7.5	3.5
0.56	0.71											
0.71	0.95	14.0	17.0	12.0	7.2	8.0	11.0	6.0	5.7	6.5	9.5	4.5
0.95	1.19											
1.19	1.58	14.5	18.0	12.0	8.6	9.5	13.0	7.0	6.6	7.5	11.0	5.0
1.58	1.97											
1.97	2.56	17.0	21.0	14.0	9.8	11.0	15.0	8.0	7.8	9.0	13.0	6.0
2.56	3.15											
3.15	3.94	19.5	25.0	16.0	11.2	12.5	18.0	9.0	9.2	10.5	16.0	7.0
3.94	4.73											
4.73	5.52	24.0	30.0	20.0	14.5	16.0	22.0	12.0	10.5	12.0	18.0	8.0
5.52	6.3											
6.3	7.09											
7.09	7.88	34.5	42.0	30.0	18.8	20.5	28.0	16.0	12.8	14.5	22.0	10.0
7.88	8.86											
8.86	9.85											
9.85	11.03	45.0	52.0	40.0	23.0	25.0	32.0	20.0	15.0	17.0	24.0	12.0
11.03	12.41											
12.41	13.98	56.0	64.0	50.0	28.5	31.0	39.0	25.0	17.5	20.0	28.0	14.0
13.98	15.75											
15.75	17.72	66.0	76.0	60.0	34.0	36.0	46.0	30.0	20.0	22.0	32.0	16.0
17.72	19.69											

Table 2 **Limits for holes (inch units)** *(continued)*
Tolerance unit = 0.001 inch

Nominal sizes (in)		D					E				F				
		8	9	10	11	8–11	7	8	9	7–9	6	7	8	9	6–9
Over	To	High +	High +	High +	High +	Low +	High +	High +	High +	Low +	High +	High +	High +	High +	Low +
0.04	0.12	1.6	2.0	2.6	3.5	1.0	1.0	1.2	1.6	0.6	0.55	0.7	0.9	1.3	0.3
0.12	0.24	1.9	2.4	3.0	4.2	1.2	1.3	1.5	2.0	0.8	0.7	0.9	1.1	1.6	0.4
0.24	0.40	2.5	3.0	3.8	5.1	1.6	1.6	1.9	2.4	1.0	0.9	1.1	1.4	1.9	0.5
0.40	0.56	3.0	3.6	4.8	6.0	2.0	1.9	2.2	2.8	1.2	1.0	1.3	1.6	2.2	0.6
0.56	0.71														
0.71	0.95	3.7	4.5	6.0	7.5	2.5	2.4	2.8	3.6	1.6	1.3	1.6	2.0	2.8	0.8
0.95	1.19														
1.19	1.58	4.6	5.5	7.0	9.0	3.0	3.0	3.6	4.5	2.0	1.6	2.0	2.6	—	1.0
1.58	1.97														
1.97	2.56	5.8	7.0	8.5	11.0	4.0	3.7	4.3	5.5	2.5	1.9	2.4	3.0	—	1.2
2.56	3.15														
3.15	3.94	7.2	8.5	10.0	14.0	5.0	4.4	5.2	6.5	3.0	2.3	2.8	3.6	—	1.4
3.94	4.73														
4.73	5.52	8.5	10.0	12.0	16.0	6.0	5.1	6.0	7.5	3.5	2.6	3.2	4.1	—	1.6
5.52	6.3														
6.3	7.09														
7.09	7.88	9.8	11.5	14.0	19.0	7.0	5.8	6.8	8.5	4.0	3.2	3.8	4.8	—	2.0
7.88	8.86														
8.86	9.85														
9.85	11.03	10.0	12.0	15.0	19.0	7.0	6.5	7.5	9.5	4.5	3.4	4.2	5.2	—	2.2
11.03	12.41														
12.41	13.98	11.5	14.0	17.0	22.0	8.0	7.2	8.5	11.0	5.0	3.9	4.7	6.0	—	2.5
13.98	15.75														
15.75	17.72	13.0	15.0	19.0	25.0	9.0	7.5	9.0	11.0	5.0	4.4	5.3	6.8	—	2.8
17.72	19.69														

Table 2 **Limits for holes (inch units)** *(continued)*
Tolerance unit = 0.001 inch

<table>
<tr><th colspan="2">Nominal sizes</th><th colspan="3">G</th><th colspan="8">H</th></tr>
<tr><th colspan="2">(in)</th><th>6</th><th>7</th><th>6, 7</th><th>5</th><th>6</th><th>7</th><th>8</th><th>9</th><th>10</th><th>11</th><th>12</th></tr>
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<tr><td>0.40</td><td>0.56</td><td rowspan="2">0.65</td><td rowspan="2">0.95</td><td rowspan="2">0.25</td><td rowspan="2">0.3</td><td rowspan="2">0.4</td><td rowspan="2">0.7</td><td rowspan="2">1.0</td><td rowspan="2">1.6</td><td rowspan="2">2.8</td><td rowspan="2">4.0</td><td rowspan="2">7.0</td></tr>
<tr><td>0.56</td><td>0.71</td></tr>
<tr><td>0.71</td><td>0.95</td><td rowspan="2">0.8</td><td rowspan="2">1.1</td><td rowspan="2">0.3</td><td rowspan="2">0.4</td><td rowspan="2">0.5</td><td rowspan="2">0.8</td><td rowspan="2">1.2</td><td rowspan="2">2.0</td><td rowspan="2">3.5</td><td rowspan="2">5.0</td><td rowspan="2">8.0</td></tr>
<tr><td>0.95</td><td>1.19</td></tr>
<tr><td>1.19</td><td>1.58</td><td rowspan="2">1.0</td><td rowspan="2">1.4</td><td rowspan="2">0.4</td><td rowspan="2">0.4</td><td rowspan="2">0.6</td><td rowspan="2">1.0</td><td rowspan="2">1.6</td><td rowspan="2">2.5</td><td rowspan="2">4.0</td><td rowspan="2">6.0</td><td rowspan="2">10.0</td></tr>
<tr><td>1.58</td><td>1.97</td></tr>
<tr><td>1.97</td><td>2.56</td><td rowspan="2">1.1</td><td rowspan="2">1.6</td><td rowspan="2">0.4</td><td rowspan="2">0.5</td><td rowspan="2">0.7</td><td rowspan="2">1.2</td><td rowspan="2">1.8</td><td rowspan="2">3.0</td><td rowspan="2">4.5</td><td rowspan="2">7.0</td><td rowspan="2">12.0</td></tr>
<tr><td>2.56</td><td>3.15</td></tr>
<tr><td>3.15</td><td>3.94</td><td rowspan="2">1.4</td><td rowspan="2">1.9</td><td rowspan="2">0.5</td><td rowspan="2">0.6</td><td rowspan="2">0.9</td><td rowspan="2">1.4</td><td rowspan="2">2.2</td><td rowspan="2">3.5</td><td rowspan="2">5.0</td><td rowspan="2">9.0</td><td rowspan="2">14.0</td></tr>
<tr><td>3.94</td><td>4.73</td></tr>
<tr><td>4.73</td><td>5.52</td><td rowspan="3">1.6</td><td rowspan="3">2.2</td><td rowspan="3">0.6</td><td rowspan="3">0.7</td><td rowspan="3">1.0</td><td rowspan="3">1.6</td><td rowspan="3">2.5</td><td rowspan="3">4.0</td><td rowspan="3">6.0</td><td rowspan="3">10.0</td><td rowspan="3">16.0</td></tr>
<tr><td>5.52</td><td>6.3</td></tr>
<tr><td>6.3</td><td>7.09</td></tr>
<tr><td>7.09</td><td>7.88</td><td rowspan="3">1.8</td><td rowspan="3">2.4</td><td rowspan="3">0.6</td><td rowspan="3">0.8</td><td rowspan="3">1.2</td><td rowspan="3">1.8</td><td rowspan="3">2.8</td><td rowspan="3">4.5</td><td rowspan="3">7.0</td><td rowspan="3">12.0</td><td rowspan="3">18.0</td></tr>
<tr><td>7.88</td><td>8.86</td></tr>
<tr><td>8.86</td><td>9.85</td></tr>
<tr><td>9.85</td><td>11.03</td><td rowspan="2">1.9</td><td rowspan="2">2.7</td><td rowspan="2">0.7</td><td rowspan="2">0.9</td><td rowspan="2">1.2</td><td rowspan="2">2.0</td><td rowspan="2">3.0</td><td rowspan="2">5.0</td><td rowspan="2">8.0</td><td rowspan="2">12.0</td><td rowspan="2">20.0</td></tr>
<tr><td>11.03</td><td>12.41</td></tr>
<tr><td>12.41</td><td>13.98</td><td rowspan="2">2.1</td><td rowspan="2">2.9</td><td rowspan="2">0.7</td><td rowspan="2">1.0</td><td rowspan="2">1.4</td><td rowspan="2">2.2</td><td rowspan="2">3.5</td><td rowspan="2">6.0</td><td rowspan="2">9.0</td><td rowspan="2">14.0</td><td rowspan="2">22.0</td></tr>
<tr><td>13.98</td><td>15.75</td></tr>
<tr><td>15.75</td><td>17.72</td><td rowspan="2">2.4</td><td rowspan="2">3.3</td><td rowspan="2">0.8</td><td rowspan="2">1.0</td><td rowspan="2">1.6</td><td rowspan="2">2.5</td><td rowspan="2">4.0</td><td rowspan="2">6.0</td><td rowspan="2">10.0</td><td rowspan="2">16.0</td><td rowspan="2">25.0</td></tr>
<tr><td>17.72</td><td>19.69</td></tr>
</table>

Table 2 **Limits for holes (inch units)** *(continued)*
Tolerance unit = 0.001 inch

Nominal sizes		**H**		**J**											
(in)		**13**	**5–13**	**6**		**7**		**8**		**9**		**10**		**11**	
Over	**To**	**High** +	**Low**	**High** +	**Low** −	**High** +	**Low** −	**High** +	**Low** −	**High** +	**Low** −	**High** +	**Low** −	**High** +	**Low** −
0.04	0.12	6.0	0	0.15	0.1	0.25	0.15	0.3	0.3	0.5	0.5	0.8	0.8	1.2	1.3
0.12	0.24	7.0	0	0.2	0.1	0.3	0.2	0.3	0.4	0.6	0.6	0.9	0.9	1.5	1.5
0.24	0.40	9.0	0	0.25	0.15	0.3	0.3	0.5	0.4	0.7	0.7	1.1	1.1	1.7	1.8
0.40	0.56	10.0	0	0.25	0.15	0.4	0.3	0.5	0.5	0.8	0.8	1.4	1.4	2.0	2.0
0.56	0.71														
0.71	0.95	12.0	0	0.3	0.2	0.5	0.3	0.7	0.5	1.0	1.0	1.7	1.8	2.5	2.5
0.95	1.19														
1.19	1.58	16.0	0	0.4	0.2	0.6	0.4	1.0	0.6	1.2	1.3	2.0	2.0	3.0	3.0
1.58	1.97														
1.97	2.56	18.0	0	0.5	0.2	0.8	0.4	1.1	0.7	1.5	1.5	2.2	2.3	3.5	3.5
2.56	3.15														
3.15	3.94	22.0	0	0.7	0.2	0.9	0.5	1.4	0.8	1.7	1.8	2.5	2.5	4.5	4.5
3.94	4.73														
4.73	5.52	25.0	0	0.7	0.3	1.0	0.6	1.6	0.9	2.0	2.0	3.0	3.0	5.0	5.0
5.52	6.3														
6.3	7.09														
7.09	7.88	28.0	0	0.9	0.3	1.1	0.7	1.8	1.0	2.2	2.3	3.5	3.5	6.0	6.0
7.88	8.86														
8.86	9.85														
9.85	11.03	30.0	0	0.9	0.3	1.3	0.7	2.0	1.0	2.5	2.5	4.0	4.0	6.0	6.0
11.03	12.41														
12.41	13.98	35.0	0	1.1	0.3	1.5	0.9	2.3	1.2	3.0	3.0	4.5	4.5	7.0	7.0
13.98	15.75														
15.75	17.72	40.0	0	1.3	0.3	1.6	0.9	2.7	1.3	3.0	3.0	5.0	5.0	8.0	8.0
17.72	19.69														

Table 2 **Limits for holes (inch units)** *(continued)*
Tolerance unit = 0.001 inch

Nominal sizes (in)		**K**						**M**					
		6		**7**		**8**		**6**		**7**		**8**	
Over	**To**	**High** +	**Low** −	**High** +	**Low** −	**High** +	**Low** −	**High** −	**Low** −	**High**	**Low** −	**High** +	**Low** −
0.04	0.12	—	—	—	—	—	—	0.1	0.35	0	0.4	0	0.6
0.12	0.24	—	—	—	—	—	—	0.1	0.4	0	0.5	0	0.7
0.24	0.40	0	0.4	0.1	0.5	0.2	0.7	0.1	0.5	0	0.6	0	0.9
0.40	0.56	0	0.4	0.2	0.5	0.2	0.8	0.2	0.6	0	0.7	0	1.0
0.56	0.71												
0.71	0.95	0	0.5	0.2	0.6	0.3	0.9	0.2	0.7	0	0.8	0.1	1.1
0.95	1.19												
1.19	1.58	0.1	0.5	0.3	0.7	0.5	1.1	0.2	0.8	0	1.0	0.2	1.4
1.58	1.97												
1.97	2.56	0.1	0.6	0.4	0.8	0.5	1.3	0.3	1.0	0	1.2	0.2	1.6
2.56	3.15												
3.15	3.94	0.2	0.7	0.4	1.0	0.7	1.5	0.3	1.2	0	1.4	0.3	1.9
3.94	4.73												
4.73	5.52	0.2	0.8	0.5	1.1	0.8	1.7	0.3	1.3	0	1.6	0.3	2.2
5.52	6.3												
6.3	7.09												
7.09	7.88	0.2	1.0	0.5	1.3	0.8	2.0	0.3	1.5	0	1.8	0.4	2.4
7.88	8.86												
8.86	9.85												
9.85	11.03	0.2	1.0	0.6	1.4	0.8	2.2	0.4	1.6	0	2.0	0.4	2.6
11.03	12.41												
12.41	13.98	0.2	1.2	0.6	1.6	1.1	2.4	0.4	1.8	0	2.2	0.5	3.0
13.98	15.75												
15.75	17.72	0.4	1.2	0.7	1.8	1.3	2.7	0.4	2.0	0	2.5	0.6	3.4
17.72	19.69												

Table 2 **Limits for holes (inch units)** *(continued)*
Tolerance unit = 0.001 inch

Nominal sizes (in)		**N**										**P**			
		6		**7**		**8**		**9, 10, 11**	**9**	**10**	**11**	**6**		**7**	
Over	**To**	**High** –	**Low** –	**High** –	**Low** –	**High** –	**Low** –	**High**	**Low** –	**Low** –	**Low** –	**High** –	**Low** –	**High** –	**Low** –
0.04	0.12	0.2	0.45	0.1	0.5	0.1	0.7	0	1.0	1.6	2.5	0.35	0.6	0.25	0.65
0.12	0.24	0.2	0.5	0.1	0.6	0.1	0.8	0	1.2	1.8	3.0	0.4	0.7	0.3	0.8
0.24	0.40	0.25	0.65	0.2	0.8	0.1	1.0	0	1.4	2.2	3.5	0.5	0.9	0.4	1.0
0.40	0.56	0.4	0.8	0.2	0.9	0.2	1.2	0	1.6	2.8	4.0	0.6	1.0	0.4	1.1
0.56	0.71														
0.71	0.95	0.5	1.0	0.3	1.1	0.2	1.4	0	2.0	3.5	5.0	0.7	1.2	0.5	1.3
0.95	1.19														
1.19	1.58	0.5	1.1	0.3	1.3	0.2	1.8	0	2.5	4.0	6.0	0.8	1.4	0.6	1.6
1.58	1.97														
1.97	2.56	0.6	1.3	0.3	1.5	0.2	2.0	0	3.0	4.5	7.0	1.2	1.9	0.9	2.1
2.56	3.15														
3.15	3.94	0.7	1.6	0.5	1.9	0.2	2.4	0	3.5	5.0	9.0	1.3	2.2	1.1	2.5
3.94	4.73														
4.73	5.52	0.9	1.9	0.6	2.2	0.3	2.8	0	4.0	6.0	10.0	1.5	2.5	1.2	2.8
5.52	6.3														
6.3	7.09														
7.09	7.88	1.0	2.2	0.8	2.6	0.4	3.2	0	4.5	7.0	12.0	1.6	2.8	1.4	3.2
7.88	8.86														
8.86	9.85														
9.85	11.03	1.1	2.3	0.8	2.8	0.4	3.4	0	5.0	8.0	12.0	1.9	3.1	1.4	3.4
11.03	12.41														
12.41	13.98	1.2	2.6	0.8	3.0	0.5	4.0	0	6.0	9.0	14.0	2.1	3.5	1.7	3.9
13.98	15.75														
15.75	17.72	1.2	2.8	0.9	3.4	0.5	4.5	0	6.0	10.0	16.0	2.2	3.8	1.9	4.4
17.72	19.69														

Table 2 **Limits for holes (inch units)** *(continued)*
Tolerance unit = 0.001 inch

Nominal sizes (in)		R				S				T			
		6		7		6		7		6		7	
Over	**To**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**
		–	–	–	–	–	–	–	–	–	–	–	–
0.04	0.12	0.45	0.7	0.3	0.7	0.55	0.8	0.4	0.8	—	—	—	—
0.12	0.24	0.5	0.8	0.4	0.9	0.6	0.9	0.5	1.0	—	—	—	—
0.24	0.40	0.7	1.1	0.6	1.2	0.8	1.2	0.8	1.4	—	—	—	—
0.40	0.56	0.9	1.3	0.7	1.4	1.1	1.5	0.9	1.6	—	—	—	—
0.56	0.71												
0.71	0.95	1.1	1.6	0.9	1.7	1.3	1.8	1.1	1.9	—	—	—	—
0.95	1.19									1.5	2.0	1.3	2.1
1.19	1.58	1.2	1.8	1.0	2.0	1.6	2.2	1.4	2.4	1.8	2.4	1.6	2.6
1.58	1.97									2.0	2.6	1.8	2.8
1.97	2.56	1.4	2.1	1.1	2.3	1.8	2.5	1.5	2.7	2.3	3.0	2.0	3.2
2.56	3.15					2.0	2.7	1.7	2.9	2.8	3.5	2.5	3.7
3.15	3.94	1.7	2.6	1.5	2.9	2.5	3.4	2.3	3.7	3.2	4.1	3.0	4.4
3.94	4.73					2.7	3.6	2.5	3.9	3.7	4.6	3.5	4.9
4.73	5.52	2.2	3.2	1.9	3.5	3.2	4.2	2.9	4.5	4.7	5.7	4.4	6.0
5.52	6.3					3.7	4.7	3.4	5.0	4.7	5.7	4.4	6.0
6.3	7.09					4.2	5.2	3.9	5.5	5.7	6.7	5.4	7.0
7.09	7.88	2.6	3.8	2.4	4.2	4.6	5.8	4.4	6.2	6.6	7.8	6.4	8.2
7.88	8.86					4.6	5.8	4.4	6.2	6.6	7.8	6.4	8.2
8.86	9.85					5.6	6.8	5.2	7.0	7.6	8.8	7.4	9.2
9.85	11.03	3.2	4.4	2.7	4.7	5.7	6.9	5.2	7.2	8.7	9.9	8.2	10.2
11.03	12.41					6.5	7.7	6.2	8.2	8.7	9.9	8.2	10.2
12.41	13.98	4.1	5.5	3.7	5.9	6.6	8.0	6.2	8.4	9.6	11.0	9.2	11.4
13.98	15.75					7.6	9.0	7.2	9.4	11.0	12.4	11.2	13.4
15.75	17.72	4.4	6.0	4.1	6.6	8.4	10.0	8.1	10.6	11.4	13.0	11.5	14.0
17.72	19.69					9.4	11.0	9.1	11.6	13.4	15.0	13.1	15.6

Table 2 **Limits for holes (inch units)** *(continued)*
Tolerance unit = 0.001 inch

Nominal sizes (in)		U				V				X				Y		Z	
		6		7		6		7		6		7		7		7	
Over	**To**	**High** −	**Low** −	**High** −	**Low** −	**High** −	**Low** −	**High** −	**Low** −	**High** −	**Low** −	**High** −	**Low** −	**High** −	**Low** −	**High** −	**Low** −
0.04	0.12	0.65	0.9	0.6	1.0	—	—	—	—	0.85	1.1	0.8	1.2	—	—	1.05	1.45
0.12	0.24	0.8	1.1	0.7	1.2	—	—	—	—	1.1	1.4	1.0	1.5	—	—	1.2	1.7
0.24	0.40	1.0	1.4	1.0	1.6	—	—	—	—	1.3	1.7	1.2	1.8	—	—	1.4	2.0
0.40	0.56	1.3	1.7	1.1	1.8	—	—	—	—	1.5	1.9	1.3	2.0	—	—	1.7	2.4
0.56	0.71					1.5	1.9	1.3	2.0	1.7	2.1	1.5	2.2	—	—	2.2	2.9
0.71	0.95	1.5	2.0	1.3	2.1	1.7	2.2	1.5	2.3	2.1	2.6	1.9	2.7	2.2	3.0	2.5	3.3
0.95	1.19	1.7	2.2	1.5	2.3	2.1	2.6	1.9	2.7	2.4	2.9	2.2	3.0	2.7	3.5	3.2	4.0
1.19	1.58	2.3	2.9	2.1	3.1	2.6	3.2	2.4	3.4	2.8	3.4	2.6	3.6	3.1	4.1	4.1	5.1
1.58	1.97	2.6	3.2	2.4	3.4	2.8	3.4	2.6	3.6	3.8	4.4	3.6	4.6	4.1	5.1	4.6	5.6
1.97	2.56	3.3	4.0	3.0	4.2	3.8	4.5	3.5	4.7	4.8	5.5	4.5	5.7	5.5	6.7	6.5	7.7
2.56	3.15	3.8	4.5	3.5	4.7	4.8	5.5	4.5	5.7	5.8	6.5	5.5	6.7	6.5	7.7	7.5	8.7
3.15	3.94	4.7	5.6	4.5	5.9	5.7	6.6	5.5	6.9	6.7	7.6	6.5	7.9	7.5	8.9	9.5	10.9
3.94	4.73	5.7	6.6	5.5	6.9	6.7	7.6	6.5	7.9	7.7	8.6	7.5	8.9	9.5	10.9	11.5	12.9
4.73	5.52	6.7	7.7	6.4	8.0	7.7	8.7	7.4	9.0	9.7	10.7	9.4	11.0	11.4	13.0	13.4	15.0
5.52	6.3	6.7	7.7	6.4	8.0	8.7	9.7	8.4	10.0	11.7	12.7	11.4	13.0	13.4	15.0	15.4	17.0
6.3	7.09	7.7	8.7	7.4	9.0	9.7	10.7	9.4	11.0	11.7	12.7	11.4	13.0	13.4	15.0	17.4	19.0
7.09	7.88	8.6	9.8	8.4	10.2	11.6	12.8	11.4	13.2	13.6	14.8	13.4	15.2	15.4	17.2	19.4	21.2
7.88	8.86	9.6	10.8	9.4	11.2	11.6	12.8	11.4	13.2	15.6	16.8	15.4	17.2	17.4	19.2	21.4	23.2
8.86	9.85	11.6	12.8	11.4	13.2	13.6	14.8	13.4	15.2	15.6	16.8	15.4	17.2	19.4	21.2	24.4	26.2
9.85	11.03	11.7	12.9	11.4	13.4	15.7	16.9	15.2	17.2	17.7	18.9	17.2	19.2	21.2	23.2	27.2	29.2
11.03	12.41	13.7	14.9	13.2	15.2	15.7	16.9	15.2	17.2	19.7	20.9	19.2	21.2	24.2	26.2	29.2	31.2
12.41	13.98	15.6	17.0	15.2	17.4	17.6	19.0	17.2	19.4	21.6	23.0	21.2	23.4	27.2	29.4	34.2	36.4
13.98	15.75	17.6	19.0	17.2	19.4	19.6	21.0	19.2	21.4	24.6	26.0	24.2	26.4	29.2	31.4	39.2	41.4
15.75	17.72	19.4	21.0	19.1	21.6	21.4	23.0	21.1	23.6	27.4	29.0	27.1	29.6	34.1	36.6	44.1	46.6
17.72	19.69	21.4	23.0	21.1	23.6	24.4	26.0	24.1	26.6	29.4	31.0	29.1	31.6	39.1	41.6	49.1	51.6

Table 3 **Limits for shafts (inch units)**
Tolerance unit = 0.001 inch

Nominal sizes		**a**			**b**				**c**			
(in)		**9, 11**	**9**	**11**	**8–11**	**8**	**9**	**11**	**8–11**	**8**	**9**	**11**
Over	**To**	**High**	**Low**	**Low**	**High**	**Low**	**Low**	**Low**	**High**	**Low**	**Low**	**Low**
		–	–	–	–	–	–	–	–	–	–	–
0.04	0.12	10.0	11.0	12.5	5.0	5.6	6.0	7.5	2.5	3.1	3.5	5.0
0.12	0.24	10.0	11.2	13.0	5.0	5.7	6.2	8.0	2.8	3.5	4.0	5.8
0.24	0.40	10.0	11.4	13.5	6.0	6.9	7.4	9.5	3.0	3.9	4.4	6.5
0.40	0.56	12.0	13.6	16.0	6.0	7.0	7.6	10.0	3.5	4.5	5.1	7.5
0.56	0.71											
0.71	0.95	12.0	14.0	17.0	6.0	7.2	8.0	11.0	4.5	5.7	6.5	9.5
0.95	1.19											
1.19	1.58	12.0	14.5	18.0	7.0	8.6	9.5	13.0	5.0	6.6	7.5	11.0
1.58	1.97											
1.97	2.56	14.0	17.0	21.0	8.0	9.8	11.0	15.0	6.0	7.8	9.0	13.0
2.56	3.15											
3.15	3.94	16.0	19.5	25.0	9.0	11.2	12.5	18.0	7.0	9.2	10.5	16.0
3.94	4.73											
4.73	5.52	20.0	24.0	30.0	12.0	14.5	16.0	22.0	8.0	10.5	12.0	18.0
5.52	6.3											
6.3	7.09											
7.09	7.88	30.0	34.5	42.0	16.0	18.8	20.5	28.0	10.0	12.8	14.5	22.0
7.88	8.86											
8.86	9.85											
9.85	11.03	40.0	45.0	52.0	20.0	23.0	25.0	32.0	12.0	15.0	17.0	24.0
11.03	12.41											
12.41	13.98	50.0	56.0	64.0	25.0	28.5	31.0	39.0	14.0	17.5	20.0	28.0
13.98	15.75											
15.75	17.72	60.0	66.0	76.0	30.0	34.0	36.0	46.0	16.0	20.0	22.0	32.0
17.72	19.69											

Table 3 **Limits for shafts (inch units)** *(continued)*
Tolerance unit = 0.001 inch

Nominal sizes (in)		d					e				f			
		8–11	8	9	10	11	7–9	7	8	9	6–8	6	7	8
Over	To	High –	Low –	Low –	Low –	Low –	High –	Low –	Low –	Low –	High –	Low –	Low –	Low –
0.04	0.12	1.0	1.6	2.0	2.6	3.5	0.6	1.0	1.2	1.6	0.3	0.55	0.7	0.9
0.12	0.24	1.2	1.9	2.4	3.0	4.2	0.8	1.3	1.5	2.0	0.4	0.7	0.9	1.1
0.24	0.40	1.6	2.5	3.0	3.8	5.1	1.0	1.6	1.9	2.4	0.5	0.9	1.1	1.4
0.40	0.56	2.0	3.0	3.6	4.8	6.0	1.2	1.9	2.2	2.8	0.6	1.0	1.3	1.6
0.56	0.71													
0.71	0.95	2.5	3.7	4.5	6.0	7.5	1.6	2.4	2.8	3.6	0.8	1.3	1.6	2.0
0.95	1.19													
1.19	1.58	3.0	4.6	5.5	7.0	9.0	2.0	3.0	3.6	4.5	1.0	1.6	2.0	2.6
1.58	1.97													
1.97	2.56	4.0	5.8	7.0	8.5	11.0	2.5	3.7	4.3	5.5	1.2	1.9	2.4	3.0
2.56	3.15													
3.15	3.94	5.0	7.2	8.5	10.0	14.0	3.0	4.4	5.2	6.5	1.4	2.3	2.8	3.6
3.94	4.73													
4.73	5.52	6.0	8.5	10.0	12.0	16.0	3.5	5.1	6.0	7.5	1.6	2.6	3.2	4.1
5.52	6.3													
6.3	7.09													
7.09	7.88	7.0	9.8	11.5	14.0	19.0	4.0	5.8	6.8	8.5	2.0	3.2	3.8	4.8
7.88	8.86													
8.86	9.85													
9.85	11.03	7.0	10.0	12.0	15.0	19.0	4.5	6.5	7.5	9.5	2.2	3.4	4.2	5.2
11.03	12.41													
12.41	13.98	8.0	11.5	14.0	17.0	22.0	5.0	7.2	8.5	11.0	2.5	3.9	4.7	6.0
13.98	15.75													
15.75	17.72	9.0	13.0	15.0	19.0	25.0	5.0	7.5	9.0	11.0	2.8	4.4	5.3	6.8
17.72	19.69													

Table 3 **Limits for shafts (inch units)** *(continued)*
Tolerance unit = 0.001 inch

Nominal sizes (in)		g			h							
		5, 6	**5**	**6**	**5–13**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Over	**To**	**High** –	**Low** –	**Low** –	**High**	**Low** –	**Low** –	**Low** –	**Low** –	**Low** –	**Low** –	**Low** –
0.04	0.12	0.1	0.3	0.35	0	0.2	0.25	0.4	0.6	1.0	1.6	2.5
0.12	0.24	0.15	0.35	0.45	0	0.2	0.3	0.5	0.7	1.2	1.8	3.0
0.24	0.40	0.2	0.45	0.6	0	0.25	0.4	0.6	0.9	1.4	2.2	3.5
0.40	0.56	0.25	0.55	0.65	0	0.3	0.4	0.7	1.0	1.6	2.8	4.0
0.56	0.71											
0.71	0.95	0.3	0.7	0.8	0	0.4	0.5	0.8	1.2	2.0	3.5	5.0
0.95	1.19											
1.19	1.58	0.4	0.8	1.0	0	0.4	0.6	1.0	1.6	2.5	4.0	6.0
1.58	1.97											
1.97	2.56	0.4	0.9	1.1	0	0.5	0.7	1.2	1.8	3.0	4.5	7.0
2.56	3.15											
3.15	3.94	0.5	1.1	1.4	0	0.6	0.9	1.4	2.2	3.5	5.0	9.0
3.94	4.73											
4.73	5.52	0.6	1.3	1.6	0	0.7	1.0	1.6	2.5	4.0	6.0	10.0
5.52	6.3											
6.3	7.09											
7.09	7.88	0.6	1.4	1.8	0	0.8	1.2	1.8	2.8	4.5	7.0	12.0
7.88	8.86											
8.86	9.85											
9.85	11.03	0.7	1.6	1.9	0	0.9	1.2	2.0	3.0	5.0	8.0	12.0
11.03	12.41											
12.41	13.98	0.7	1.7	2.1	0	1.0	1.4	2.2	3.5	6.0	9.0	14.0
13.98	15.75											
15.75	17.72	0.8	1.8	2.4	0	1.0	1.6	2.5	4.0	6.0	10.0	16.0
17.72	19.69											

Table 3 **Limits for shafts (inch units)** *(continued)*
Tolerance unit = 0.001 inch

Nominal sizes (in)		h		j															
		12	13	5		6		7		8		9		10		11			
Over	To	Low −	Low −	High +	Low −	High +	Low −	High +	Low −	High +	Low −	High +	Low −	High +	Low −	High +	Low −		
0.04	0.12	4.0	6.0	0.1	0.1	0.15	0.1	0.3	0.1	0.3	0.3	0.5	0.5	0.8	0.8	1.3	1.2		
0.12	0.24	5.0	7.0	0.1	0.1	0.2	0.1	0.4	0.1	0.4	0.3	0.6	0.6	0.9	0.9	1.5	1.5		
0.24	0.40	6.0	9.0	0.15	0.1	0.3	0.1	0.4	0.2	0.5	0.4	0.7	0.7	1.1	1.1	1.8	1.7		
0.40	0.56	7.0	10.0	0.2	0.1	0.3	0.1	0.5	0.2	0.5	0.5	0.8	0.8	1.4	1.4	2.0	2.0		
0.56	0.71																		
0.71	0.95	8.0	12.0	0.2	0.2	0.3	0.2	0.5	0.3	0.6	0.6	1.0	1.0	1.8	1.7	2.5	2.5		
0.95	1.19																		
1.19	1.58	10.0	16.0	0.2	0.2	0.4	0.2	0.6	0.4	0.8	0.8	1.3	1.2	2.0	2.0	3.0	3.0		
1.58	1.97																		
1.97	2.56	12.0	18.0	0.2	0.3	0.4	0.3	0.7	0.5	0.9	0.9	1.5	1.5	2.3	2.2	3.5	3.5		
2.56	3.15																		
3.15	3.94	14.0	22.0	0.2	0.4	0.5	0.4	0.8	0.6	1.1	1.1	1.8	1.7	2.5	2.5	4.5	4.5		
3.94	4.73																		
4.73	5.52	16.0	25.0	0.3	0.4	0.6	0.4	0.9	0.7	1.3	1.2	2.0	2.0	3.0	3.0	5.0	5.0		
5.52	6.3																		
6.3	7.09																		
7.09	7.88	18.0	28.0	0.3	0.5	0.7	0.5	1.0	0.8	1.4	1.4	2.3	2.2	3.5	3.5	6.0	6.0		
7.88	8.86																		
8.86	9.85																		
9.85	11.03	20.0	30.0	0.3	0.6	0.7	0.6	1.0	1.0	1.5	1.5	2.5	2.5	4.0	4.0	6.0	6.0		
11.03	12.41																		
12.41	13.98	22.0	35.0	0.3	0.7	0.7	0.7	1.2	1.0	1.8	1.7	3.0	3.0	4.5	4.5	7.0	7.0		
13.98	15.75																		
15.75	17.72	25.0	40.0	0.3	0.7	0.9	0.7	1.3	1.2	2.0	2.0	3.0	3.0	5.0	5.0	8.0	8.0		
17.72	19.69																		

Table 3 **Limits for shafts (inch units)** *(continued)*
Tolerance unit = 0.001 inch

Nominal sizes (in)		**k**									**m**	
		5	**6**	**7**	**5–7**	**8**	**9**	**10**	**11**	**8–11**	**5**	**6**
Over	**To**	**High** +	**High** +	**High** +	**Low** +	**High** +	**High** +	**High** +	**High** +	**Low**	**High** +	**High** +
0.04	0.12	—	—	—	—	0.6	1.0	1.6	2.5	0	0.35	0.4
0.12	0.24	—	—	—	—	0.7	1.2	1.8	3.0	0	0.4	0.5
0.24	0.40	0.35	0.5	0.7	0.1	0.9	1.4	2.2	3.5	0	0.45	0.6
0.40	0.56	0.4	0.5	0.8	0.1	1.0	1.6	2.8	4.0	0	0.6	0.7
0.56	0.71											
0.71	0.95	0.5	0.6	0.9	0.1	1.2	2.0	3.5	5.0	0	0.7	0.8
0.95	1.19											
1.19	1.58	0.5	0.7	1.1	0.1	1.6	2.5	4.0	6.0	0	0.8	1.0
1.58	1.97											
1.97	2.56	0.6	0.8	1.3	0.1	1.8	3.0	4.5	7.0	0	1.0	1.2
2.56	3.15											
3.15	3.94	0.7	1.0	1.5	0.1	2.2	3.5	5.0	9.0	0	1.1	1.4
3.94	4.73											
4.73	5.52	0.8	1.1	1.7	0.1	2.5	4.0	6.0	10.0	0	1.3	1.6
5.52	6.3											
6.3	7.09											
7.09	7.88	1.0	1.4	2.0	0.2	2.8	4.5	7.0	12.0	0	1.4	1.8
7.88	8.86											
8.86	9.85											
9.85	11.03	1.1	1.4	2.2	0.2	3.0	5.0	8.0	12.0	0	1.7	2.0
11.03	12.41											
12.41	13.98	1.2	1.6	2.4	0.2	3.5	6.0	9.0	14.0	0	1.8	2.2
13.98	15.75											
15.75	17.72	1.2	1.8	2.7	0.2	4.0	6.0	10.0	16.0	0	1.9	2.5
17.72	19.69											

Table 3 **Limits for shafts (inch units)** *(continued)*
Tolerance unit = 0.001 inch

Nominal sizes		m		n				p				r			
(in)		7	5–7	5	6	7	5–7	5	6	7	5–7	5	6	7	5–7
Over	To	High	Low	High	High	High	Low	High	High	High	Low	High	High	High	Low
		+	+	+	+	+	+	+	+	+	+	+	+	+	+
0.04	0.12	0.55	0.15	0.45	0.5	0.65	0.25	0.6	0.65	0.8	0.4	0.7	0.75	0.9	0.5
0.12	0.24	0.7	0.2	0.5	0.6	0.8	0.3	0.7	0.8	1.0	0.5	0.8	0.9	1.1	0.6
0.24	0.40	0.8	0.2	0.65	0.8	1.0	0.4	0.85	1.0	1.2	0.6	1.05	1.2	1.4	0.8
0.40	0.56	1.0	0.3	0.8	0.9	1.2	0.5	1.0	1.1	1.4	0.7	1.3	1.4	1.7	1.0
0.56	0.71														
0.71	0.95	1.1	0.3	1.0	1.1	1.4	0.6	1.2	1.3	1.6	0.8	1.6	1.7	2.0	1.2
0.95	1.19														
1.19	1.58	1.4	0.4	1.1	1.3	1.7	0.7	1.4	1.6	2.0	1.0	1.8	2.0	2.4	1.4
1.58	1.97														
1.97	2.56	1.7	0.5	1.3	1.5	2.0	0.8	1.9	2.1	2.6	1.4	2.1	2.3	2.8	1.6
2.56	3.15														
3.15	3.94	1.9	0.5	1.6	1.9	2.4	1.0	2.2	2.5	3.0	1.6	2.6	2.9	3.4	2.0
3.94	4.73														
4.73	5.52	2.2	0.6	1.9	2.2	2.8	1.2	2.5	2.8	3.4	1.8	3.2	3.5	4.1	2.5
5.52	6.3														
6.3	7.09														
7.09	7.88	2.4	0.6	2.2	2.6	3.2	1.4	2.8	3.2	3.8	2.0	3.8	4.2	4.8	3.0
7.88	8.86														
8.86	9.85														
9.85	11.03	2.8	0.8	2.3	2.6	3.4	1.4	3.1	3.4	4.2	2.2	4.4	4.7	5.5	3.5
11.03	12.41														
12.41	13.98	3.0	0.8	2.6	3.0	3.8	1.6	3.5	3.9	4.7	2.5	5.5	5.9	6.7	4.5
13.98	15.75														
15.75	17.72	3.4	0.9	2.8	3.4	4.3	1.8	3.8	4.4	5.3	2.8	6.0	6.6	7.5	5.0
17.72	19.69														

Table 3 **Limits for shafts (inch units)** *(continued)*
Tolerance unit = 0.001 inch

Nominal sizes		**s**				**t**				**u**			
(in)		**5**	**6**	**7**	**5–7**	**5**	**6**	**7**	**5–7**	**5**	**6**	**7**	**5–7**
Over	**To**	**High** +	**High** +	**High** +	**Low** +	**High** +	**High** +	**High** +	**Low** +	**High** +	**High** +	**High** +	**Low** +
0.04	0.12	0.8	0.85	1.0	0.6	—	—	—	—	0.9	0.95	1.1	0.7
0.12	0.24	0.9	1.0	1.2	0.7	—	—	—	—	1.1	1.2	1.4	0.9
0.24	0.40	1.25	1.4	1.6	1.0	—	—	—	—	1.45	1.6	1.8	1.2
0.40	0.56	1.5	1.6	1.9	1.2	—	—	—	—	1.7	1.8	2.1	1.4
0.56	0.71												
0.71	0.95	1.8	1.9	2.2	1.4	—	—	—	—	2.0	2.1	2.4	1.6
0.95	1.19					2.0	2.1	2.4	1.6	2.2	2.3	2.6	1.8
1.19	1.58	2.2	2.4	2.8	1.8	2.4	2.6	3.0	2.0	2.9	3.1	3.5	2.5
1.58	1.97					2.6	2.8	3.2	2.2	3.2	3.4	3.8	2.8
1.97	2.56	2.5	2.7	3.2	2.0	3.0	3.2	3.7	2.5	4.0	4.2	4.7	3.5
2.56	3.15	2.7	2.9	3.4	2.2	3.5	3.7	4.2	3.0	4.5	4.7	5.2	4.0
3.15	3.94	3.4	3.7	4.2	2.8	4.1	4.4	4.9	3.5	5.6	5.9	6.4	5.0
3.94	4.73	3.6	3.9	4.4	3.0	4.6	4.9	5.4	4.0	6.6	6.9	7.4	6.0
4.73	5.52	4.2	4.5	5.1	3.5	5.7	6.0	6.6	5.0	7.7	8.0	8.6	7.0
5.52	6.3	4.7	5.0	5.6	4.0	5.7	6.0	6.6	5.0	7.7	8.0	8.6	7.0
6.3	7.09	5.2	5.5	6.1	4.5	6.7	7.0	7.6	6.0	8.7	9.0	9.6	8.0
7.09	7.88	5.8	6.2	6.8	5.0	7.8	8.2	8.8	7.0	9.8	10.2	10.8	9.0
7.88	8.86	5.8	6.2	6.8	5.0	7.8	8.2	8.8	7.0	10.8	11.2	11.8	10.0
8.86	9.85	6.8	7.2	7.8	6.0	8.8	9.2	9.8	8.0	12.8	13.2	13.8	12.0
9.85	11.03	6.9	7.2	8.0	6.0	9.9	10.2	11.0	9.0	12.9	13.2	14.0	12.0
11.03	12.41	7.9	8.2	9.0	7.0	9.9	10.2	11.0	9.0	14.9	15.2	16.0	14.0
12.41	13.98	8.0	8.4	9.2	7.0	11.0	11.4	12.2	10.0	17.0	17.4	18.2	16.0
13.98	15.75	9.0	9.4	10.2	8.0	13.0	13.4	14.2	12.0	19.0	19.4	20.2	18.0
15.75	17.72	10.0	10.6	11.5	9.0	13.0	13.6	14.5	12.0	21.0	21.6	22.5	20.0
17.72	19.69	11.0	11.6	12.5	10.0	15.0	15.6	16.5	14.0	23.0	23.6	24.5	22.0

Table 3 **Limits for shafts (inch units)** *(continued)*
Tolerance unit = 0.001 inch

Nominal sizes		v				x				y			z		
(in)		5	6	7	5–7	5	6	7	5–7	6	7	6, 7	6	7	6, 7
Over	To	High	High	High	Low	High	High	High	Low	High	High	Low	High	High	Low
		+	+	+	+	+	+	+	+	+	+	+	+	+	+
0.04	0.12	—	—	—	—	1.1	1.15	1.3	0.9	—	—	—	1.45	1.6	1.2
0.12	0.24	—	—	—	—	1.4	1.5	1.7	1.2	—	—	—	1.7	1.9	1.4
0.24	0.40	—	—	—	—	1.65	1.8	2.0	1.4	—	—	—	2.0	2.2	1.6
0.40	0.56	—	—	—	—	1.9	2.0	2.3	1.6	—	—	—	2.4	2.7	2.0
0.56	0.71	1.9	2.0	2.3	1.6	2.1	2.2	2.5	1.8	—	—	—	2.9	3.2	2.5
0.71	0.95	2.2	2.3	2.6	1.8	2.6	2.7	3.0	2.2	3.0	3.3	2.5	3.3	3.6	2.8
0.95	1.19	2.6	2.7	3.0	2.2	2.9	3.0	3.3	2.5	3.5	3.8	3.0	4.0	4.3	3.5
1.19	1.58	3.2	3.4	3.8	2.8	3.4	3.6	4.0	3.0	4.1	4.5	3.5	5.1	5.5	4.5
1.58	1.97	3.4	3.6	4.0	3.0	4.4	4.6	5.0	4.0	5.1	5.5	4.5	5.6	6.0	5.0
1.97	2.56	4.5	4.7	5.2	4.0	5.5	5.7	6.2	5.0	6.7	7.2	6.0	7.7	8.2	7.0
2.56	3.15	5.5	5.7	6.2	5.0	6.5	6.7	7.2	6.0	7.7	8.2	7.0	8.7	9.2	8.0
3.15	3.94	6.6	6.9	7.4	6.0	7.6	7.9	8.4	7.0	8.9	9.4	8.0	10.9	11.4	10.0
3.94	4.73	7.6	7.9	8.4	7.0	8.6	8.9	9.4	8.0	10.9	11.4	10.0	12.9	13.4	12.0
4.73	5.52	8.7	9.0	9.6	8.0	10.7	11.0	11.6	10.0	13.0	13.6	12.0	15.0	15.6	14.0
5.52	6.3	9.7	10.0	10.6	9.0	12.7	13.0	13.6	12.0	15.0	15.6	14.0	17.0	17.6	16.0
6.3	7.09	10.7	11.0	11.6	10.0	12.7	13.0	13.6	12.0	15.0	15.6	14.0	19.0	19.6	18.0
7.09	7.88	12.8	13.2	13.8	12.0	14.8	15.2	15.8	14.0	17.2	17.8	16.0	21.2	21.8	20.0
7.88	8.86	12.8	13.2	13.8	12.0	16.8	17.2	17.8	16.0	19.2	19.8	18.0	23.2	23.8	22.0
8.86	9.85	14.8	15.2	15.8	14.0	16.8	17.2	17.8	16.0	21.2	21.8	20.0	26.2	26.8	25.0
9.85	11.03	16.9	17.2	18.0	16.0	18.9	19.2	20.0	18.0	23.2	24.0	22.0	29.2	30.0	28.0
11.03	12.41	16.9	17.2	18.0	16.0	20.9	21.2	22.0	20.0	26.2	27.0	25.0	31.2	32.0	30.0
12.41	13.98	19.0	19.4	20.2	18.0	23.0	23.4	24.2	22.0	29.4	30.2	28.0	36.4	37.2	35.0
13.98	15.75	21.0	21.4	22.2	20.0	26.0	26.4	27.2	25.0	31.4	32.2	30.0	41.4	42.2	40.0
15.75	17.72	23.0	23.6	24.5	22.0	29.0	29.6	30.5	28.0	36.6	37.5	35.0	46.6	47.5	45.0
17.72	19.69	26.0	26.6	27.5	25.0	31.0	31.6	32.5	30.0	41.6	42.5	40.0	51.6	52.5	50.0

Annex A (informative) Rules for rounding-off tolerances

To avoid the use of excessively precise tolerances, the theoretical values of all the fundamental deviations and tolerances have been rounded-off to values selected from the preferred series of tolerances in Table A.1.

Table A.1 **Preferred series of tolerances**
Unit = 0.001 in

0.1	0.3	1	3	10	30
		1.2	3.5	12	35
	0.4	1.4	4	14	40
0.15					
		1.6	4.5	16	45
	0.5	1.8	5	18	50
0.2	0.6	2	6	20	60
	0.7	2.2	7	22	
0.25	0.8	2.5	8	25	
	0.9	2.8	9	28	

Exceptions to this rule are tolerances for IT1 to IT3 which are intended primarily for gauges. These have been rounded-off to a finer degree.

Annex B (informative) Derivation of fundamental deviations

The method of determining the fundamental deviations[1] for the various fits as used in the inch conversion is given in Table B.1.

The fundamental deviations of the holes "A" to "G" are identical with those of the shafts "a" to "g" but of opposite sign.

In the case of limits "a" to "h" and "A" to "H", the formulae give the upper limits of tolerance of shafts and the lower limits of tolerance of holes. In the case of limits "k" to "z" and "K" to "Z", the formulae give the lower limits of tolerance of shafts and the upper limits of tolerance of holes.

NOTE 1 All tolerances are expressed in units of 0.001 in.

NOTE 2 Diameter D is expressed in inches and is, in all cases, the geometric mean of the diameter steps involved.

Table B.1 **Method of determining the fundamental deviations for the various fits**

Shafts and holes	Method
a, A	When "D" is less than or equal to 4.73 in: 1.3D + 10.5 When "D" is greater than 4.73 in: 3.5D
b, B	When "D" is less than or equal to 6.3 in: 0.85D + 5.5 When "D" is greater than 6.3 in: 1.8D
c, C	When "D" is less than or equal to 1.58 in: $3.9D^{0.2}$ When "D" is greater than 1.58 in: 0.8D + 3.75
d, D	$2.62D^{0.44}$
e, E	$1.63D^{0.41}$
f, F	$0.82D^{0.41}$
g, G	$0.3D^{0.34}$
h, H	0
j, J	For grades 5, 6 and 7, both shaft limits of tolerance are determined in a purely arbitrary fashion based on experience. The lower limits of tolerances of the holes J6, J7 and J8 are the same as the upper limits of tolerance of shafts j5, j6 and j7 respectively but of opposite sign. For j8 and J9 and after, the fundamental tolerance is divided equally plus and minus. To avoid awkward division where the tolerance value is an odd number, the plus for the shaft and the minus for the hole is given the greater integral number, e.g. 15 = 8 + 7.
k	For grades 5, 6 and 7, the lower limit of tolerance of the shaft is determined according to the formula $k = 0.07\sqrt[3]{D}$. For grades 8, 9, 10 and 11, the lower limit of tolerance for the shaft is zero but these qualities are not intended for fits.
K	The lower limits of tolerances of the holes K6, K7 and K8, which are the only holes listed, are the same as the upper limits of tolerance of shafts k5, k6 and k7 respectively, but of opposite sign.
m	$0.32\sqrt[3]{D}$. *NOTE In the case of m6, the upper limit of tolerance is adjusted to correspond with the hole H7 and this results in a corresponding departure from the theoretical value of the lower limits of tolerances of "m" shafts.*

[1] See Clause **6**.

Table B.1 **Method of determining the fundamental deviations for the various fits** *(continued)*

M	The lower limits of tolerances of the holes M6, M7 and M8 are the same as the upper limits of tolerance of shafts m5, m6 and m7 respectively, but of opposite sign.
n	$0.59D^{0.34}$ with the overriding consideration that the result has to be greater than H6 except in the smallest sizes.
N	The lower limits of tolerance of the holes N6, N7 and N8 are the same as the upper limits of tolerance of shafts n5, n6 and n7 respectively, but of opposite sign. The limits of tolerance of N9, N10 and N11 correspond exactly with shafts h9, h10 and h11.
p	The lower limit of tolerance was determined more or less arbitrarily as the same size or very slightly larger than the upper limit of tolerance of H7, since this shaft was intended as the first true interference fit. It exists in grades 5, 6 and 7 only.
P	The lower limits of tolerance of the holes P6 and P7 are the same as the upper limits of tolerance of the shafts p5 and p6 respectively but of opposite sign.
r	The lower limit of tolerance is the geometric mean of the corresponding "p" and "s" limits of tolerance.
R	The limits of tolerance for R6 and R7 are derived from r5 and r6 as for "P".
s	The limits of tolerance of these shafts always produce an interference when used with the hole H8. Up to and including diameters of 1.969 in, the fundamental limits of tolerance have been arranged arbitrarily in this way. For diameters above 1.969 in, s = 0.4D + IT7.
S	Derived as for "R"
t	As for "s" up to diameter 1.97 in For diameters above 1.97 in: t = 0.63D + IT7
T	Derived as for "R"
u	As for "s" up to diameter 0.71 in For diameters above 0.71 in: u = 1.0D + IT7
U	Derived as for "R"
v	As for "s" up to diameter 0.71 in For diameters above 0.71 in: v = 1.25D + IT7
V	Derived as for "R"
x	As for "s" up to diameter 0.71 in For diameters above 0.71 in: x = 1.6D + IT7
X	Derived as for "R"
y	For diameters above 0.71 in: y = 2.0D + IT7
Y	Derived as for "R"
z	As for "s" up to diameter 0.71 in For diameters above 0.71 in: z = 2.5D + IT7
Z	Derived as for "R"

Annex C (informative) Special notes on tables of limits

C.1 Hole limits of tolerance (Table 2)

a) Hole F9 is envisaged for precision work only up to a diameter of 1.19 in.

b) In the range 0.04 in to 0.24 in, limits for K6, K7 and K8 do not exist; the limits for J6, J7 and J8 should be used instead.

c) In the range 0.04 in to 0.95 in, limits for T6 and T7 do not exist; the limits for U6 and U7 should be used instead.

d) In the range 0.04 in to 0.56 in, limits for V6 and V7 do not exist; the limits for X6 and X7 should be used instead.

e) In the range 0.04 in to 0.71 in, limits for Y7 do not exist; the limits for Z7 should be used instead.

f) The holes "V", "X", "Y" and "Z" should not be considered as definite recommendations but for trial only. The holes "V" and "Y" should be avoided as much as possible.

C.2 Shaft limits of tolerance (Table 3)

a) In the range 0.04 in to 0.24 in, limits for k5, k6, k7 and m7 do not exist; the limits for j5, j6, j7 and n7 should be used instead.

b) In the range 0.04 in to 0.95 in, limits for t5, t6 and t7 do not exist; the limits for u5, u6 and u7 should be used instead.

c) In the range 0.04 in to 0.56 in, limits for v5, v6 and v7 do not exist; the limits for x5, x6 and x7 should be used instead.

d) In the range 0.04 in to 0.71 in, limits for y6 and y7 do not exist; the limits for z6 and z7 should be used instead.

e) The shafts "v", "x", "y" and "z" should not be considered as definite recommendations but for trial only. The shafts "v" and "y" should be avoided as much as possible.

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 1916-2, *Limits and fits for engineering – Part 2: Guide to the selection of fits in BS 1916-1*

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BS 2045, *Preferred numbers*

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[2)] Referred to in the Foreword only.

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