BRITISH STANDARD

BS 5246:1976

Incorporating
Amendment No. 1

Specification for

Pinion type cutters for spur gears — 1 to 8 metric module

UDC 621.914.6:621.833

Co-operating organizations

The Mechanical Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and professional and industrial organizations:

Associated Offices Technical Committee
Association of Consulting Engineers
Association of Hydraulic Equipment Manufacturers Ltd.
Association of Mining Electrical and Mechanical Engineers
British Compressed Air Society
British Electrical and Allied Manufacturers' Association
British Gas Corporation
British Gear Manufacturer's Association*
British Internal Combustion Engine Manufacturers' Association
British Mechanical Engineering Confederation
British Pump Manufacturers' Association
British Steel Corporation
British Steel Industry
Crown Agents for Oversea Governments and Administrations
Department of Employment (HM Factory Inspectorate)
Department of the Environment
Department of Industry — Mechanical Engineering
Department of Industry — National Engineering Laboratory*
Department of Trade
Electricity Supply Industry in England and Wales
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Society of Motor Manufacturers and Traders Ltd.
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The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

Gauge and Toolmakers Association
Milling Cutter and Reamers Association
National Federation of Engineers Tool Manufacturers
Navy and Vickers Gearing Research Association
North East Coast Institution of Engineering and Shipbuilders

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The following BSI references relate to the work on this standard:
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Draft for comment 73/32531 DC

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Amendments issued since publication

Amd. No.	Date of issue	Comments
2100	September 1976	Indicated by a sideline in the margin

Contents

Foreword

This British Standard has been prepared under the authority of the Mechanical Engineering Industry Standards Committee and is one of a number dealing with gear cutting tools.

This edition is a revision of the 1957 edition of BS 2887 but in accordance with the UK policy of metrication, diametral pitch cutters have been replaced by metric module cutters. BS 2887 is therefore withdrawn.

It should be noted that, due to established world wide usage, nominal bore sizes in inch units of $1^{1}/_{4}$, $1^{3}/_{4}$ and $2^{5}/_{16}$ have been directly converted into millimetres.

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 12, 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 specifies certain dimensions and accuracy requirements for non-topping pinion type finishing cutters for generating involute spur gear teeth of 1 to 8 metric module.

The following types of cutter are covered by this standard.

Disc [see Table 1(a) and Table 1(b)].

Extended hub (see Table 2).

Screwed hub (see Table 3).

Parallel shank (see Table 4).

Large stub taper shank (see Table 4).

No. 2 Morse stub taper shank (see Table 4).

These cutters are generally intended for the production of metric module gears which comply with the requirements of ISO 53 and ISO 54 and BS 436-2. This standard, BS 5246, includes two additional modules, 3.25 and 3.75.

Two tolerance grades are given.

Grade AA. Cutters for the production of gears to fine tolerances.

Grade A. Cutters for the production of gears for general purposes.

NOTE Grade AA is applicable to all the cutters illustrated except the screwed hub type shown in Figure 5.

Details of the markings recommended for pinion type cutters and information to be given when ordering standard cutters are included.

2 References

The titles of the British Standard and International Standards referred to in this standard are listed on the inside back cover.

3 Terminology

3.1
normal module, m_n

the quotient of the normal pitch, expressed in mm, by the number π

3.2 General.

The general terms used, common to gears and gear forming tools, are taken from BS 2519[1)].

Notations are as given in BS 2519[1)].

Figure 1 illustrates the terminology applied to a typical disc type cutter.

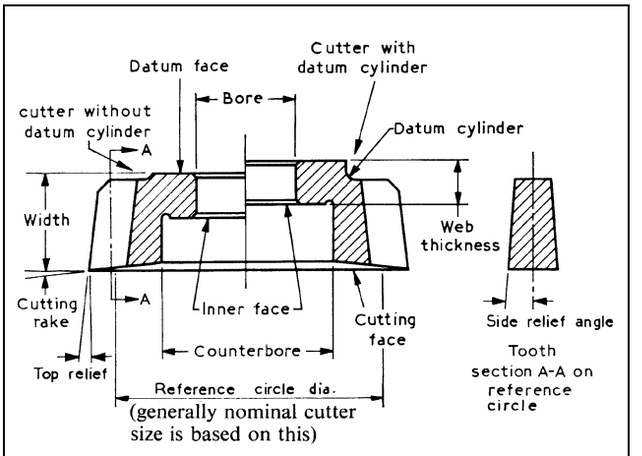


Figure 1 — Cutter terms

4 Tooth form

Pinion type cutters shall have teeth of such a form that they will be capable of generating gear teeth corresponding to the British Standard basic rack tooth profile shown in BS 436-2 except that slight changes in profile, root fillet and root clearance of the gear teeth will occur during the life of the cutter.

The actual dimensions of the following elements of the cutter shall be so related that when cutting a basic rack to the standard tooth thickness, the standard root clearance will be maintained as a minimum over the first 75 % of the useful face width of the cutter teeth:

a) outside diameter,

b) tooth thickness,

c) side relief angle,

d) top relief angle.

NOTE With certain combinations of gear and cutter sizes, gears produced by this process will give rise to incorrect tooth action. See Appendix A.

5 Dimensions

Dimensions for the cutters listed shall comply with those given in Table 1 to Table 4 as appropriate. Cutters are also manufactured and used outside the range of pitches indicated for each type but these are not covered by this standard. However, by agreement between the purchaser and manufacturer, essential features of this standard, e.g. tolerances, may be applied to such other designs.

For bore dimensions see clause **6**.

[1)] Under revision. Will also embody notations given in ISO/R 701.

6 Bore

Each end of the bore shall be broken with a small chamfer or radius not exceeding 1 mm and the bore shall be finished parallel. The dimensions of the bore shall comply with those given in Table 5.

7 Provision of datum cylinders

7.1 For grade AA cutters. All grade AA cutters shall have a datum cylinder as shown in Figure 1, Figure 2, Figure 3 and Figure 5.

7.2 For grade A disc cutters. A datum cylinder as in **7.1** above may be incorporated by arrangement between the purchaser and the manufacturer.

Other grade A cutters do not normally have a datum cylinder.

8 Tolerances

The tolerances appropriate to each type and grade of pinion cutter are given in Table 6.

In general, the tolerances for grade AA cutters apply only to the types referred to in Table 1(a), Table 1(b), Table 2 and Table 4.

9 Marking

Recommendations for the information to be marked on pinion type gear cutters are given below.

Normal module	xm_n
Normal pressure angle at reference cylinder	α_n
Number of teeth	xz
Grade of accuracy of cutter	. . .
Cutting depth	$x\ CD$
Number and year of this British Standard	BS 5246:1975

Maker's identification mark or number, and cutter material may also be added if desired.

10 Instructions for ordering

Information required by the suppliers of pinion cutters, which should be stated when ordering, is tabulated below.

Quantity required.

Type of cutter.

Normal module.

Grade of accuracy of cutter.

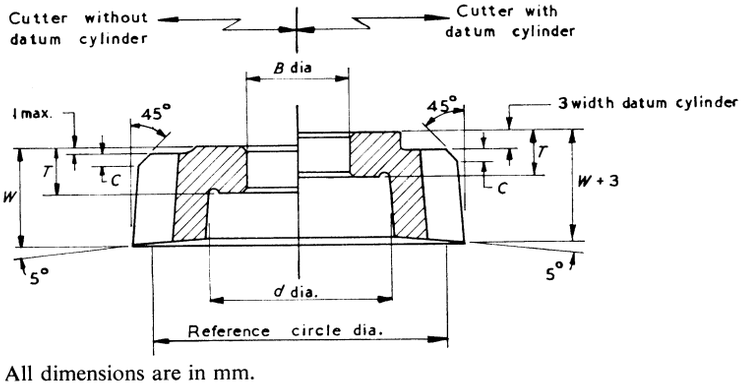
Nominal cutter size.

Diameter of bore or size and type of shank.

Number of this British Standard.

Example

One: Pinion type disc cutter, 3 metric module, Grade A, 100 mm nominal size, 31.75 mm bore, BS 5246.



All dimensions are in mm.

Figure 2 — Disc gear cutter

Table 1(a) — Disc gear cutter dimensions (see Figure 2)

(31.75 mm and 44.45 mm diameter bore)

All dimensions are in mm.

1	2	3	4	5	6	7
Module m_n	**75 mm nominal cutter size**		**100 mm nominal cutter size**		**Web thickness** T	**Chamfer** C
	Number of teeth z	**Width** W **(without datum cylinder) (See note 1)**	**Number of teeth** z	**Width** W **(without datum cylinder) (See note 1)**		
1	76	16	100	16	8	1.5
1.125	68	16	88	16		
1.25	61	16	80	16		
1.375	56	17.5	72	19		
1.5	51	17.5	66	19		
1.75	43	19	58	19		
2	38	22	50	22	10	3
2.25	34	22	44	22		
2.5	30	22	40	22		
2.75	28	22	36	22		
3	25	22	33	22		
3.25	23	25	31	25		
3.5	22	25	29	25		
3.75	20	25	27	25		
4	19	25	25	25		
4.5	17	25	22	25		
5			20	25		
5.5			18	29	12	
6			17	29		
6.5			16	29		
7			15	29		
8			13	29		
Diameter of bore B	31.75		31.75 or 44.45			
Counterbore diameter d **min. (See note 2)**	53		67			

See also Appendix A.

NOTE 1 When a datum cylinder is provided this dimension will need to be increased by 3 mm.

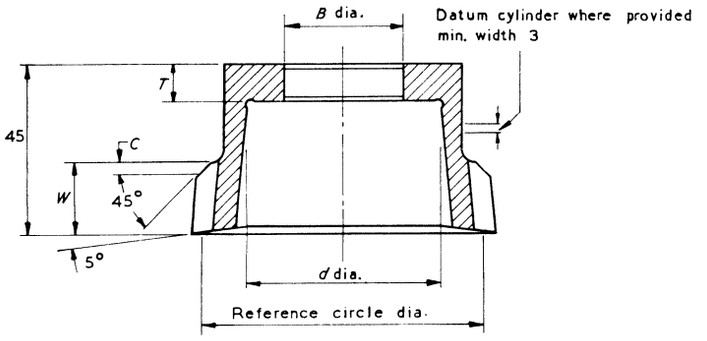
NOTE 2 The counterbore may be tapered or parallel.

Table 1(b) — Disc gear cutter dimensions (see Figure 2)

(58.738 mm diameter bore, 100 mm nominal size, with optional keyway)

All dimensions are in mm.

<table>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th><th>7</th></tr>
<tr><td>Module
m_n</td><td>No. of teeth
z</td><td>Width W (without datum cylinder) (See note 1)</td><td>Web thickness</td><td>Counterbore diameter d min. (See note 2)</td><td>Size of optional keyway in bore</td><td>Chamfer
C</td></tr>
<tr><td>1
1.125
1.25
1.375
1.50
1.75</td><td>100
88
80
72
66
58</td><td rowspan="3">25</td><td rowspan="7">13</td><td rowspan="12">78 mm min.</td><td rowspan="12">9.6 wide × 3.2 deep</td><td rowspan="3">1.5</td></tr>
<tr><td>2
2.25
2.5
2.75
3</td><td>50
44
40
36
33</td><td rowspan="9">3.0</td></tr>
<tr><td>3.25
3.5
3.75
4
4.5</td><td>31
29
27
25
23</td><td rowspan="4">29</td></tr>
<tr><td>5
5.5</td><td>21
19</td><td rowspan="4">15</td></tr>
<tr><td>6
6.5
7
8</td><td>18
17
16
14</td><td>30.5
30.5
32
33.5</td></tr>
<tr><td colspan="7">See also Appendix A.
NOTE 1 When a datum cylinder is provided this dimension will need to be increased by 3 mm.
NOTE 2 The counterbore may be tapered or parallel.</td></tr>
</table>



All dimensions are in mm.

Figure 3 — Extended hub gear cutter

Table 2 — Extended hub gear cutter dimensions (see Figure 3)

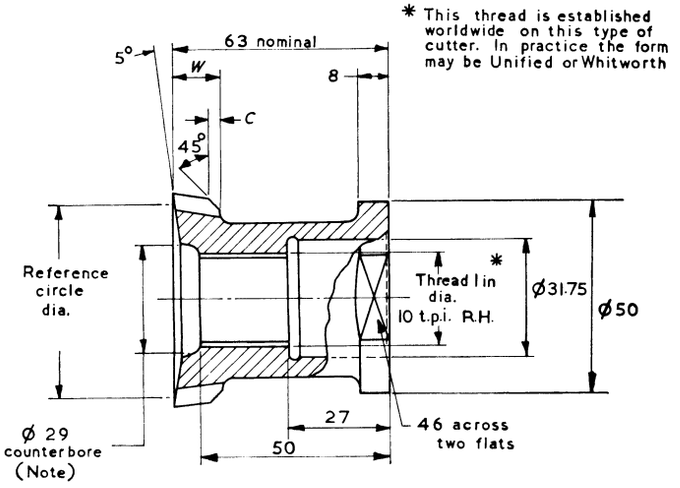
(31.75 mm and 44.45 mm diameter bore)

All dimensions are in mm.

1	2	3	4	5	6	7
Module m_n	**75 mm nominal cutter size**		**100 mm nominal cutter size**		**Web thickness**	**Chamfer**
	Number of teeth z	**Width** W	**Number of teeth** z	**Width** W	T	C
1	76	16	100	16		
1.125	68	16	88	16		
1.25	61	16	80	16		
1.375	56	17.5	72	19	9	1.5
1.5	51	17.5	66	19		
1.75	43	19	68	19		
2	38	22	50	22		
2.25	34	22	44	22		
2.5	30	22	40	22		
2.75	28	22	36	22		
3	25	22	33	22	11	
3.25	23	25	31	25		
3.5	22	25	29	25		3
3.75	20	25	27	25		
4	19	25	25	25		
4.5	17	25	22	25		
5			20	25		
5.5			18	29		
6			17	29		
6.5			16	29	13	
7			15	29		
8			13	29		
Diameter of bore B	31.75		31.75 or 44.45			
Counterbore diameter d **min. (See note)**	53		67			

See also Appendix A.

NOTE The counterbore may be tapered or parallel.



All dimensions are in mm.

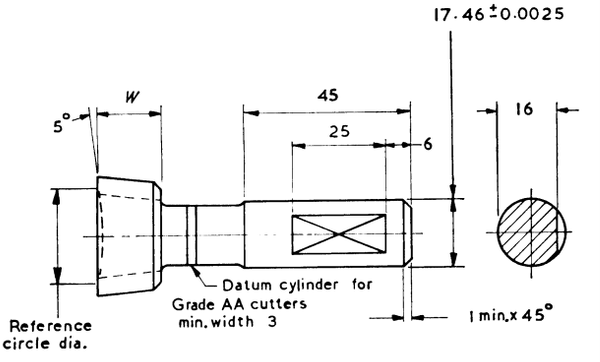
Figure 4 — Screwed hub gear cutter

Table 3 — Screwed hub gear cutter dimensions (see Figure 4)

All dimensions are in mm.

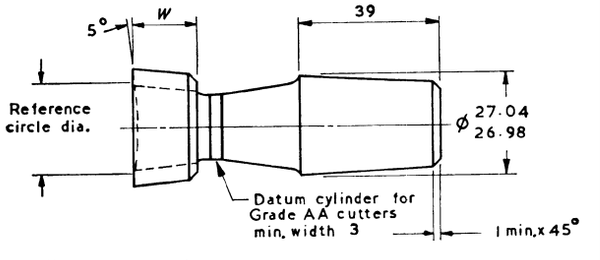
1	2	3	4	5
Module m_n	**No. of teeth** z	**Reference circle diameter**	**Width** W	**Chamfer** C
1	50	50	16	
1.125	45	50.625	16	1.5
1.25	40	50	16	
1.375	38	52.25	19	
1.50	35	52.5	19	
1.75	30	52.5	19	
2	28	56	22	
2.25	25	56.25	22	
2.50	25	62.5	22	3
2.75	23	63.25	22	
3	21	63	22	

NOTE The counterbore may be tapered or parallel.



All dimensions are in mm.

Figure 5(a) — Parallel shank gear cutter

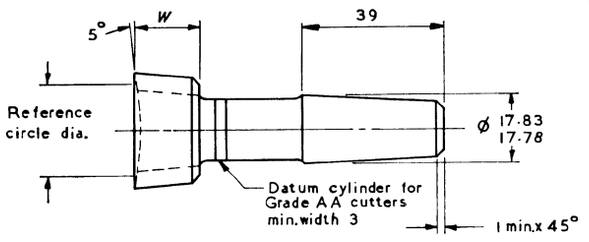


All dimensions are in mm.

Taper of shank = 0.6255 : 12

If a taper of 0.623 26 : 12 (equivalent to the no. 4 Morse rate of taper) is desired, this should be stated when making enquiries.

Figure 5(b) — Large stub taper shank gear cutter



All dimensions are in mm.

Figure 5(c) — No. 2 Morse stub taper shank gear cutter

Table 4 — Dimensions of parallel and large stub and No. 2 Morse stub taper shank gear cutters (see Figure 5)

All dimensions are in mm.

1	2	3	4
Module m_n	**Reference circle diameter**	**Width** W **min.**	**Number of teeth** z
1	25	8	25
1.125	22.5		20
1.25	20		16
1.375	24.75		18
1.50	30		20
1.75	28		16
2	28	10	14
2.25	29.25		13
2.50	30		12
2.75	33		12
3	36		12

Table 5 — Dimensions of bore

All dimensions are in mm.

1	2	3
Nominal diameter	**Limits of size Tolerance H4**	
	min.	max.
31.75	31.750	31.757
44.45	44.450	44.457
58.738	58.738	58.746

Table 6 — Accuracy tests

Tolerance unit 0.001 mm unless otherwise stated.

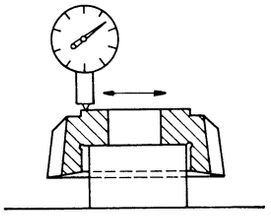
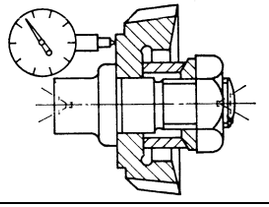
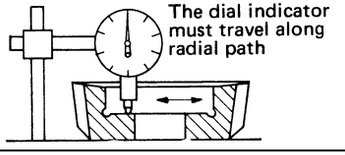
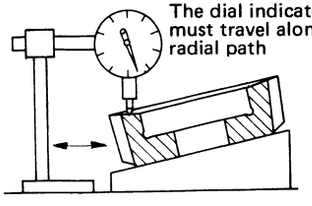
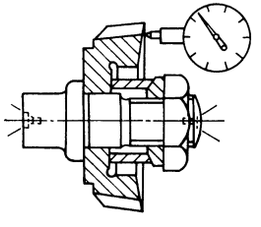
1	2	3	4	5	6	7	8	9	10
Test	Typical test arrangement (See notes 4 and 7)	Element	Test	Nominal cutter size	Grade of cutter	Tolerance			
						Module			
						⩾ 1 ⩽ 2	> 2 ⩽ 3.5	> 3.5 ⩽ 6	> 6 ⩽ 8
G1		Datum face (See note 2)	Flatness of datum face (concave only)	mm Up to 75	AA	3			
					A	5			
				100	AA	3			
					A	5			
G2		Datum face (See note 2)	Axial run-out	Up to 75	AA	3			
					A	5			
				100	AA	5			
					A	8			
G3		Inner face (See note 2)	Parallelism of inner face with datum face	All sizes	AA	3			
					A	5			
G4		Cutting face	Accuracy of cutting rake angle (5° nominal)	All sizes	AA and A	+ 0° – 0.25°			
G5		Cutting face	Axial run-out	Up to 75	AA and A	8			
				100	AA and A	10			

Table 6 — Accuracy tests

Tolerance unit 0.001 mm unless otherwise stated.

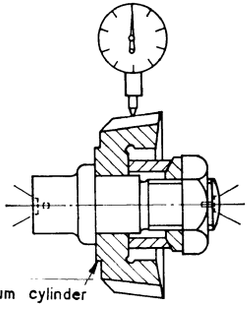
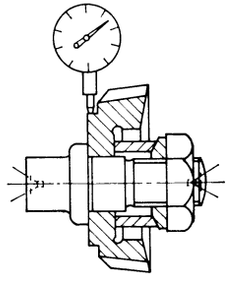
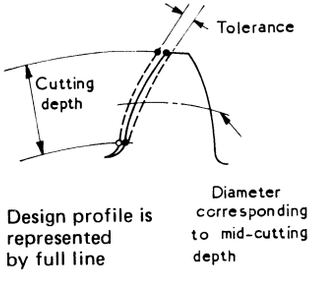
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Test	**Typical test arrangement (See notes 4 and 7)**	**Element**	**Test**	**Nominal cutter size**	**Grade of cutter**	**Tolerance**															
						Module															
						⩾ 1 ⩽ 2				**> 2 ⩽ 3.5**				**> 3.5 ⩽ 6**				**> 6 ⩽ 8**			
						Reference diameter															
						⩽ 32	**> 32 ⩽ 50**	**> 50 ⩽ 80**	**> 80 ⩽ 125**	**⩽ 32**	**> 32 ⩽ 50**	**> 50 ⩽ 80**	**> 80 ⩽ 125**	—	—	**> 50 ⩽ 80**	**> 80 ⩽ 125**	—	—	—	**> 80 ⩽ 125**
G6		Outside diameter	Run-out, relative to bore	All sizes	AA	8	8	8	8	8	8	8	8	—	—	8	8	—	—	—	8
					A	13	13	13	13	13	13	13	13	—	—	13	13	—	—	—	13
G7		Datum cylinder of disc type cutter	Run-out, relative to bore	All sizes	AA	5	5	6	6	5	5	6	6	—	—	6	6	—	—	—	6
					A	5	5	6	6	5	5	6	6	—	—	6	6	—	—	—	6
G8		Tooth (see notes 3, 5 and 6)	Profile error	All sizes	AA	3	3	3	3	4	4	4	4	—	—	4	4	—	—	—	4
					A	4	4	4	4	5	5	5	5	—	—	5	5	—	—	—	6

Table 6 — Accuracy tests

Tolerance unit 0.001 mm unless otherwise stated.

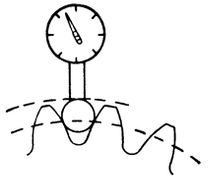
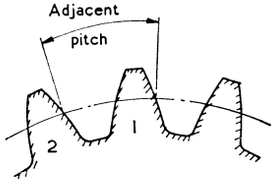
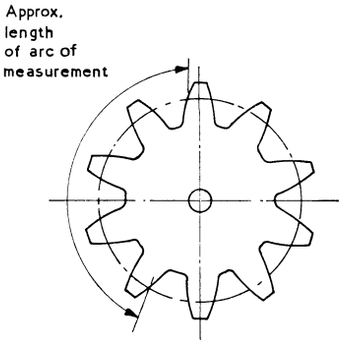
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Test	**Typical test arrangement (See notes 4 and 7)**	**Element**	**Test**	**Nominal cutter size**	**Grade of cutter**	**Tolerance**															
						Module															
						⩾ 1 ⩽ 2				**> 2 ⩽ 3.5**				**> 3.5 ⩽ 6**				**> 6 ⩽ 8**			
						Reference diameter															
						⩽ 32	**> 32 ⩽ 50**	**> 50 ⩽ 80**	**> 80 ⩽ 125**	**⩽ 32**	**> 32 ⩽ 50**	**> 50 ⩽ 80**	**> 80 ⩽ 125**	—	—	**> 50 ⩽ 80**	**> 80 ⩽ 125**	—	—	—	**> 80 ⩽ 125**
G9	Total range of indicator reading measured with a ball ended plunger contacting near the reference circle in each tooth space 	Tooth	Run-out of reference circle, relative to bore	All sizes	AA	8	9	9	9	9	9	9	9	—	—	10	10	—	—	—	12
					A	13	13	14	14	14	14	15	15	—	—	16	16	—	—	—	19
G10		Tooth	Adjacent pitch. (To be measured on each set of flanks independently)	All sizes	AA	3	3	3	3	3	3	3	3	—	—	4	4	—	—	—	4
					A	4	4	4	4	5	5	5	5	—	—	6	6	—	—	—	7

Table 6 — Accuracy tests

Tolerance unit 0.001 mm unless otherwise stated.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Test	**Typical test arrangement (See notes 4 and 7)**	**Element**	**Test**	**Nominal cutter size**	**Grade of cutter**	**Tolerance**															
						Module															
						⩾ 1 ⩽ 2				**> 2 ⩽ 3.5**				**> 3.5 ⩽ 6**				**> 6 ⩽ 8**			
						Reference diameter															
						⩽ 32	**> 32 ⩽ 50**	**> 50 ⩽ 80**	**> 80 ⩽ 125**	**⩽ 32**	**> 32 ⩽ 50**	**> 50 ⩽ 80**	**> 80 ⩽ 125**	—	—	**> 50 ⩽ 80**	**> 80 ⩽ 125**	—	—	—	**> 80 ⩽ 125**
G11		Tooth	Cumulative pitch over an arc of the reference circle not exceeding 180°	All sizes	AA	5	6	7	9	5	6	7	9	—	—	7	9	—	—	—	9
					A	8	10	11	14	8	10	11	14	—	—	11	14	—	—	—	14

NOTE 1 Unless otherwise stated the values represent the full indicator movement (FIM).
NOTE 2 Applies to disc and extended hub cutters only.
NOTE 3 Profile tolerance shall be related to "unmodified" portion of basic rack.
NOTE 4 On Grade A cutters other than the disc type, the portion of the hub or shank adjacent to the cutting portion is the datum cylinder to which the tolerances are related.
NOTE 5 When the profile is measured at the cutting face, the pressure angle has the standard value of 20°. (For this type of measurement a stylus with a flat anvil will need to be used).
NOTE 6 When the profile is measured behind the cutting face in a transverse plane the pressure angle varies from the standard value and is equal to $\tan^{-1}\left(\frac{\tan 20°}{1 - \tan 5° \tan \alpha_c}\right)$ where α_c is the top relief angle of the cutter.
NOTE 7 For convenience the drawings show only one type of cutter, but where appropriate, these tests also apply to screwed hub gear cutters, extended hub cutters and shank type cutters.

Appendix A Incorrect gear action

There are two main geometrical reasons which are likely to cause incorrect gear meshing action; these are described below.

a) If a cutter is used which is much smaller than the gear mating to the one being cut, there may be some interference between the root fillet generated by the cutter and the tip diameter of the mating gear. Thus it is necessary to consider this when choosing the size and type of cutter to be used. This condition becomes dangerous when cutting pinions where the mating wheel is large, worse when the mating gear is a rack, and much worse when the mating gear is an internal gear.

b) If a cutter with a very low number of teeth is used, involute interference will occur in the form of excessive tip modification on the gear. When cutting external gears this condition becomes worse on large gears; when cutting internal gears the condition becomes worse on small gears. In the latter case, while it is necessary to use a larger cutter to avoid or alleviate this condition, it must also be remembered that cutters for internal gears have a limit to their maximum size to avoid an interference condition which can occur during infeed.

Generally the cutter user is not in a position to analyse any of the conditions mentioned above and it is recommended that the cutter manufacturer be consulted in cases of doubt.

In certain cases, special cutters can be manufactured to give the desired gear tooth form.

Publications referred to

This standard makes reference to the following British Standard and International Standards:
BS 436, *Spur and helical gears.*
BS 436-2, *Basic rack form, modules and accuracy (1 to 50 metric module).*
BS 2519, *Glossary of terms for toothed gearing (under revision).*
ISO 53, *Basic rack of cylindrical gears for general engineering.*
ISO 54, *Modules and diametral pitches of cylindrical gears for general engineering and heavy engineering.*
ISO/R 701, *International gear notation. Symbols for geometrical data.*

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