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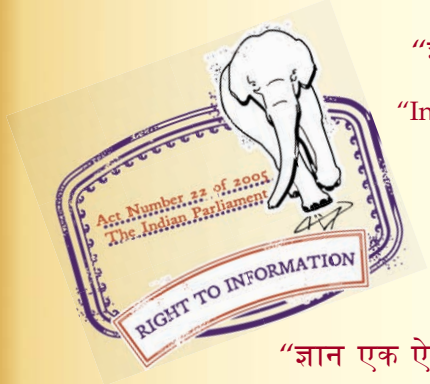
IS 2327 (1993): Straight sided splines for cylindrical shafts with internal centering - Dimensions, tolerances and verification [PGD 31: Bolts, Nuts and Fasteners Accessories]



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"Knowledge is such a treasure which cannot be stolen"

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IS 2327 : 1993
ISO 14 : 1982
(Reaffirmed 1999)

भारतीय मानक

आन्तरिक केन्द्रण वाले बेलनाकार शैफ्टों के लिये सीधे पार्श्व वाले इसप्लाईन – आयाम, छूट एवं सत्यापन

(पहला पुनरीक्षण)

Indian Standard

STRAIGHT-SIDED SPLINES FOR CYLINDRICAL SHAFTS WITH INTERNAL CENTERING — DIMENSIONS, TOLERANCES AND VERIFICATION

(First Revision)

UDC 621·824·4

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

May 1993

Price Group 6

NATIONAL FOREWORD

This Indian Standard (First Revision) which is identical with ISO 14 : 1982 'Straight-sided splines for cylindrical shafts with internal centering — Dimensions, tolerances and verification', issued by the International Organization for Standardization (ISO), was adopted by the Bureau of Indian Standards on the recommendation of the Transmission Devices Sectional Committee (LM 10) and approval of the Light Mechanical Engineering Division Council.

Splined shafts are generally used:

a) for coupling shafts when relatively heavy torques are to be transmitted without slip;

b) for transmitted power by sliding or fixed gears, pulleys and other rotating members; and

c) for attaching parts that may require removal for indexing or change in angular position.

Spline shafts and hubs have wide application in the automobile, machine tool and other industries. This standard was originally published in 1963. The present revision has been taken up to harmonize it with ISO 14 : 1982.

In the adopted standard certain terminology and conventions are not identical with those used in the Indian Standard, attention is especially drawn to the following:

a) Comma (,) has been used as decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

b) Wherever the words 'International Standard' appear referring to this standard, they shall be read as 'Indian Standard'.

Indian Standard

STRAIGHT-SIDED SPLINES FOR CYLINDRICAL SHAFTS WITH INTERNAL CENTERING — DIMENSIONS, TOLERANCES AND VERIFICATION

(First Revision)

1 Scope and field of application

This International Standard lays down dimensions, in millimetres, of straight-sided splines for cylindrical shafts with internal centering, light series and medium series.

This International Standard also specifies control methods and corresponding gauges.

2 Dimensions

The nominal dimensions common to shaft and hub, d, D and B are given in table 1. The tolerances are indicated in tables 2 and 3.

3 Designation

The profile of a splined shaft or hub shall be designated by stating, in the following order : the number of splines N, the minor diameter d and the outside diameter D, these three numbers being separated by the sign × ; for example :

Shaft (or hub) 6 × 23 × 26

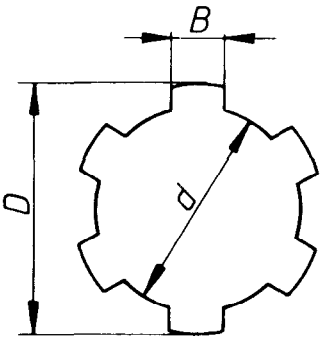


Table 1 — Nominal dimensions

d mm	Light series				Medium series			
	Designation	N	D mm	B mm	Designation	N	D mm	B mm
11					6 × 11 × 14	6	14	3
13					6 × 13 × 16	6	16	3,5
16					6 × 16 × 20	6	20	4
18					6 × 18 × 22	6	22	5
21					6 × 21 × 25	6	25	5
23	6 × 23 × 26	6	26	6	6 × 23 × 28	6	28	6
26	6 × 26 × 30	6	30	6	6 × 26 × 32	6	32	6
28	6 × 28 × 32	6	32	7	6 × 28 × 34	6	34	7
32	8 × 32 × 36	8	36	6	8 × 32 × 38	8	38	6
36	8 × 36 × 40	8	40	7	8 × 36 × 42	8	42	7
42	8 × 42 × 46	8	46	8	8 × 42 × 48	8	48	8
46	8 × 46 × 50	8	50	9	8 × 46 × 54	8	54	9
52	8 × 52 × 58	8	58	10	8 × 52 × 60	8	60	10
56	8 × 56 × 62	8	62	10	8 × 56 × 65	8	65	10
62	8 × 62 × 68	8	68	12	8 × 62 × 72	8	72	12
72	10 × 72 × 78	10	78	12	10 × 72 × 82	10	82	12
82	10 × 82 × 88	10	88	12	10 × 82 × 92	10	92	12
92	10 × 92 × 98	10	98	14	10 × 92 × 102	10	102	14
102	10 × 102 × 108	10	108	16	10 × 102 × 112	10	112	16
112	10 × 112 × 120	10	120	18	10 × 112 × 125	10	125	18

4 Tolerances on holes and shaft

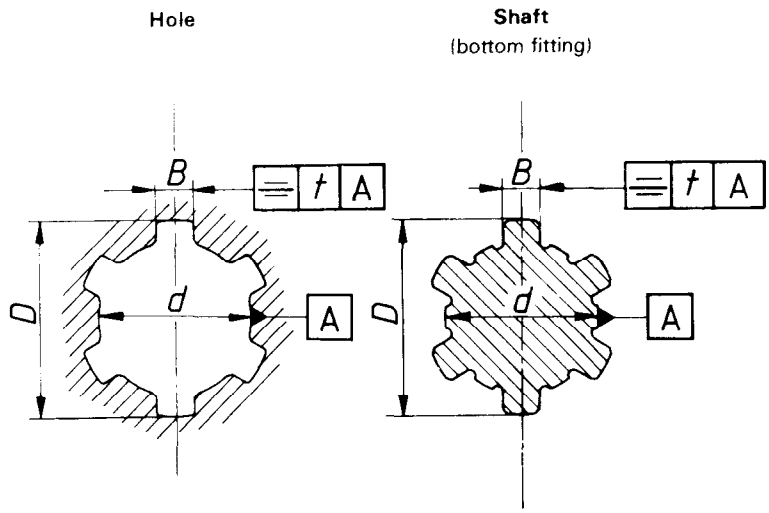


Table 2 — Tolerances on holes and shafts

Tolerances on hole						Tolerances on shaft			Mounting type
Not treated after broaching			Treated after broaching						
B	*D*	*d*	*B*	*D*	*d*	*B*	*D*	*d*	
H9	H10	H7	H11	H10	H7	d10	a11	f7	Sliding
						f9	a11	g7	Close sliding
						h10	a11	h7	Fixed

The dimensional tolerances on holes and shafts are given in table 2, whilst table 3 indicates tolerances on symmetry.

With certain milling cutters, it is possible for special applications to produce splines without bottom tool clearance with a very reduced fillet radius between the spline side and the minor diameter d (for example, milling cutters with fixed working positions).

The tolerances in table 2 above relate to entirely finished workpieces (shafts and hubs). Tooling should therefore be different for untreated workpieces or workpieces treated before machining and for workpieces treated after machining.

Table 3 — Tolerances on symmetry

Dimensions in millimetres

Spline width B	3	3,5 4 5 6	7 8 9 10	12 14 16 18
Tolerance of symmetry t	0,010 (IT7)	0,012 (IT7)	0,015 (IT7)	0,018 (IT7)

The tolerance specified on B includes the index variation (and the symmetry variation).

For alignment errors, see 5.7.

5 Gauging

5.1 General

This clause gives general information concerning gauges and gauge control; all the other requirements concerning gauges are given in clause 6 for the case where limit gauges are used, which is not compulsory. Direct measurement gauging can be permitted by previous agreement between the parties concerned according to rules to be defined to the best of requirements.

5.2 Reference temperature

The standard reference temperature of industrial measurements is 20 °C. The dimensions prescribed for parts and gauges are measured at this temperature and shall normally be checked at this temperature.

If measurements are carried out at a different temperature, the result shall be corrected taking account of the linear expansion coefficients of workpieces and gauges respectively.

Unless otherwise specified, measurements are understood with reference to a zero measuring force.

If measurements are carried out with a measuring force differing from zero, the results shall be corrected consequently. Correction however is not required for comparative measurements carried out using the same means of comparison and the same measuring force between similar elements of the same material and surface finish.

5.3 Conditions of application

A workpiece is conventionally acknowledged good when its splines are found satisfactory using gauges according to the requirements of clauses 5 and 6 of this International Standard which are authoritative for gauging. Consequently, if the customer uses his own gauges for acceptance purposes, they shall be close enough to the external limits prescribed not to reject splines already accepted by the manufacturer's gauges.

In the case of dispute, both the manufacturer and customer should make their gauges available to each other for checking at their respective sites. In the event of continuing dispute the gauges shall be referred to a recognized calibration authority.

5.4 Shaft gauging

5.4.1 GO side

Shaft gauging on the GO side is carried out using a spline GO ring gauge simultaneously checking those characteristics relating to :

5.4.1.1 fitting, i.e. :

- spline minor diameter.

5.4.1.2 mounting, i.e. :

- spline major diameter;
- spline thickness;
- major and minor diameter concentricity;
- spline angular position;
- spline position and orientation with respect to the axis.[1]

5.4.2 NOT GO side

Shaft gauging on the NOT GO side is carried out using segmental NOT GO gauges checking each element separately, i.e. :

- for spline major diameters : a calliper gauge or a plain ring gauge;
- for spline minor diameters : a calliper gauge (with appropriate special anvils, if necessary);
- for spline thicknesses : a calliper gauge (of appropriate external shape if necessary).

5.5 Hole gauging

5.5.1 GO side

Hole gauging on the GO side is carried out using a spline GO plug gauge simultaneously checking those characteristics relating to :

5.5.1.1 fitting, i.e :

- spline minor diameter.

5.5.1.2 mounting, i.e :

- spline major diameter;
- spline space width;
- major and minor diameter concentricity;
- spline angular position;
- spline position and orientation with respect to the axis.[1]

5.5.2 NOT GO side

Hole gauging on the NOT GO side is carried out using NOT GO segmental gauges checking each element separately, i.e. :

- for spline minor diameters : a cylindrical plain plug gauge;
- for spline major diameters : a cylindrical plate gauge with appropriate measuring faces;
- for spline space widths : a plate gauge.

5.6 Additional gauging

Workpiece (hole or shaft) gauging on the GO side by means of spline (plug or ring) gauges does not make it possible, if a workpiece is rejected by the gauge, to determine which element of the workpiece has provoked rejection.

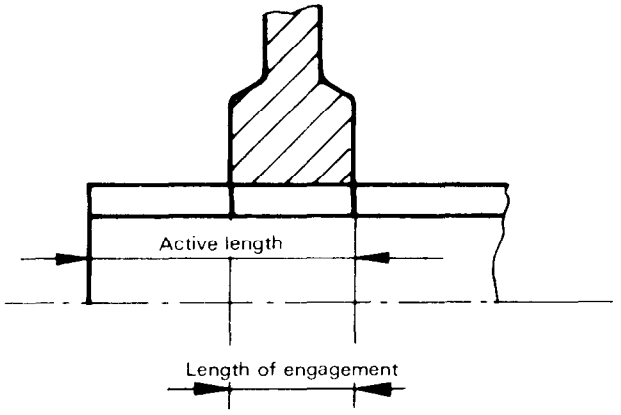
In case such indications are required, they may be obtained by **additional gauging** (to be prescribed explicitly) using segmental gauges controlling each element separately on the GO side.

5.7 Influence of active length and engagement length

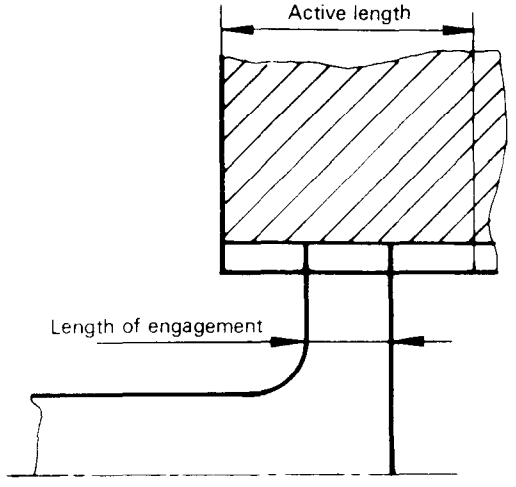
Length of engagement g_γ : The axial length of contact between mating splines.

Active length g_w : The maximum axial length in contact (when working) with the mating spline. For sliding splines, the active length exceeds the length of engagement

[1] Spline position and orientation with respect to the axis need be verified only where gauges are lacking.



a) Shaft longer than hole



b) Hole longer than shaft

Figure — Active length and engagement length

As gauges are generally smaller than gauged workpieces, the active length and length of engagement can influence the maximum permissible errors of alignment of splines (errors of parallelism of splines with respect to the axis).

If the active length is equal to the length of engagement, spline alignment errors will in general and unless otherwise specified be included in dimensional tolerances and checked simultaneously.

If the active length is longer than the length of engagement, it might be necessary to prescribe spline alignment errors independent of dimensional tolerances; such tolerances may then be checked separately, for example, by direct measurement.

If spline alignment tolerances are to be prescribed, it shall be considered that they must generally be all the smaller as the active length is longer.

5.8 Conditions of use of gauges

5.8.1 GO side

GO gauges (spline ring or plug gauge) shall slide without clearance over the whole length of the gauged workpiece under their own weight or in accordance with a fixed working load, gauging being carried out at three angular positions at least, evenly distributed over the surface. The gauge may be moved slightly to and fro in order to minimise the effects of friction.

5.8.2 NOT GO side

NOT GO segmental gauges are used in the same way as gauges intended for plain workpiece checking. Gauging is carried out at all angular positions.

5.9 Gauge control

5.9.1 GO side

GO gauges are normally controlled by direct measurement.

5.9.2 NOT GO side

NOT GO segmental gauges are controlled under the same conditions as gauges for plain workpiece gauging.

6 Definitions of gauges

6.1 General

This clause defines the positions and values of tolerances for GO and NOT GO gauges and their permissible wear limits on the GO side. It also specifies the length of gauge measuring parts.

The general indications concerning gauges and gauge control are given in clause 5.

NOTES

1 When gauges are manufactured at the maximum material limit, they shall not present form errors outside permitted tolerances.

2 To limit the number of gauges, only one GO spline plug gauge is provided to check the minimum limits of hub dimensions (whether treated or not after broaching).

3 In the following texts, the phrase **zero gauge line** has been used to designate the theoretical line from which GO gauges are positioned in analogy with the **zero assembly line** (nominal dimension).

The position of the "zero gauge line" has been determined as a function of workpiece limits at the maximum material condition, in order to satisfy assembly and operation requirements taking account of the fact that GO gauges are not segmental gauges but full form gauges.

The "zero gauge line" is in some cases coincident with the zero assembly line (or nominal dimension of assembly).

4 In conformity with clause 4, the minor diameter serves for workpiece fitting. This diameter has therefore been taken as reference for the control of geometrical defects on other elements (i.e. the other diameter of width B of splines).

In this context the phrases **dimensions for fitting** and **dimensions not ensuring fitting** have been used to designate the various elements.

6.2 Basic principles

6.2.1 GO gauges

GO gauges are full form gauges checking spline minor diameter d, major diameter D and width B simultaneously.

6.2.1.1 GO gauging of dimensions for fitting (minor diameter d)

For GO gauging of minor diameter d ensuring fitting, the values and positions of dimensional tolerances of hole or shaft gauges, the wear limits and form tolerances shall conform to the requirements of ISO/R 1938, *ISO system of limits and fits Part 2 : Inspection of plain workpieces.*

6.2.1.2 GO gauging of dimensions not ensuring fitting

6.2.1.2.1 Position of **zero gauge line**

For GO gauging of major diameter D not ensuring fitting the zero gauge line common to both shaft and hole is located at mid-distance between shaft and hole at the maximum permissible material condition of the workpieces concerned.

For GO gauging of width B, the three cases considered in clause 4 shall be taken into account, i.e. sliding, close sliding or fixed type mounting.

a) Sliding type mounting :

The zero gauge line common to both shaft and hole is located as in 6.2.1.2.1 at mid-distance between shaft and hole at the maximum permissible material condition of the workpieces.

b) Close sliding type mounting :

The hole gauge (plug gauge) is the same as for sliding type mounting gauging and the hole zero gauge line therefore lies in the same position.

For the shaft gauge (ring gauge), the zero gauge line is located on the zero line (nominal dimension), without taking into account mid-distance between shaft and hole at the maximum permissible material condition of the workpieces.

c) Fixed type mounting :

The hole gauge (plug gauge) is the same as for sliding or close sliding type mounting gauging and the hole zero gauge line therefore lies in the same position.

For the shaft gauge (ring gauge) the shaft zero gauge line is located with respect to the shaft maximum permissible material condition (nominal dimension) above the limit at a distance equal to that retained for sliding type mounting, i.e. half the deviation allowance.[1)]

6.2.1.2.2 Values and positions of tolerances and wear limits for GO gauging of dimensions not ensuring fitting.

The values of dimensional tolerances for hole or shaft GO gauges correspond to values of grade 6 and include both dimensional and form errors (namely concentricity, symmetry, angular position, helix, alignment, etc.).

The deviations between the zero gauge lines as defined in 6.2.1.2.1 and the values of grade 6 quantities closest to zero lines correspond to grade 4 values.

Gauge wear limits coincide with above mentioned zero gauge lines.

6.2.2 NOT GO gauges

NOT GO gauges are segmental gauges checking spline minor diameter d, major diameter D or width B separately.

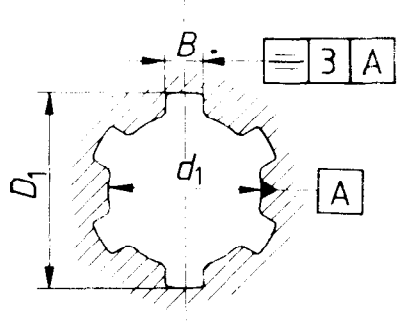
For NOT GO gauging of each element separately, the values and positions of gauge tolerances shall conform to the requirements of ISO/R 1938, *ISO system of limits and fits Part 2 : Inspection of plain workpieces.*

6.3 Tables of tolerance positions and values

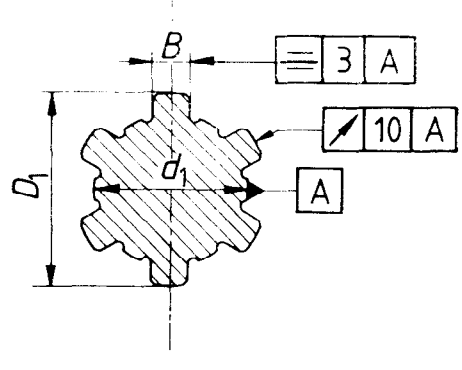
(for hubs, shafts, GO gauges and NOT GO gauges, see tables 4, 5 and 6)

6.3.1 Tolerances of symmetry and tolerances of backlash of the major diameter D_1 with respect to the minor diameter d_1

Ring gauge Tolerances in micrometres



Plug gauge

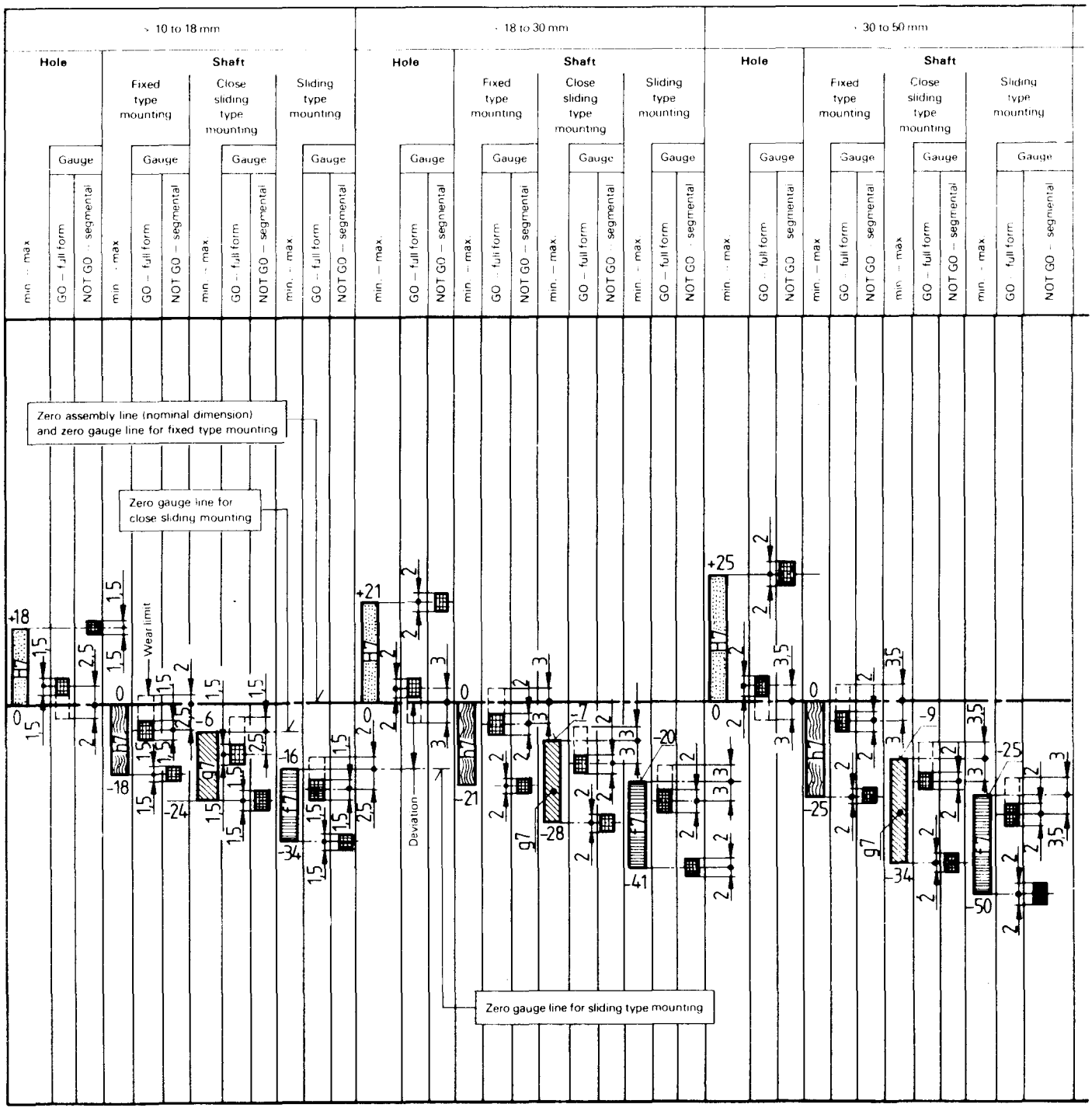


1) The deviation allowance is simply labelled "deviation" in tables 4, 5 and 6.

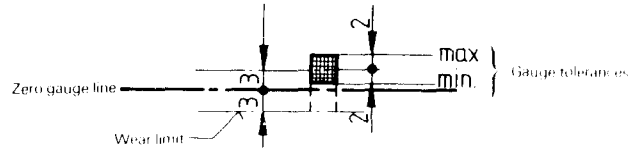
6.3.2 Tables for fitting and not fitting diameters and for spline widths

Table 4 — Diameter for

(Tolerances in micrometres)



Example of reading for (hole) GO gauge for dimensions – 18 to 30 mm



fitting – Minor diameter

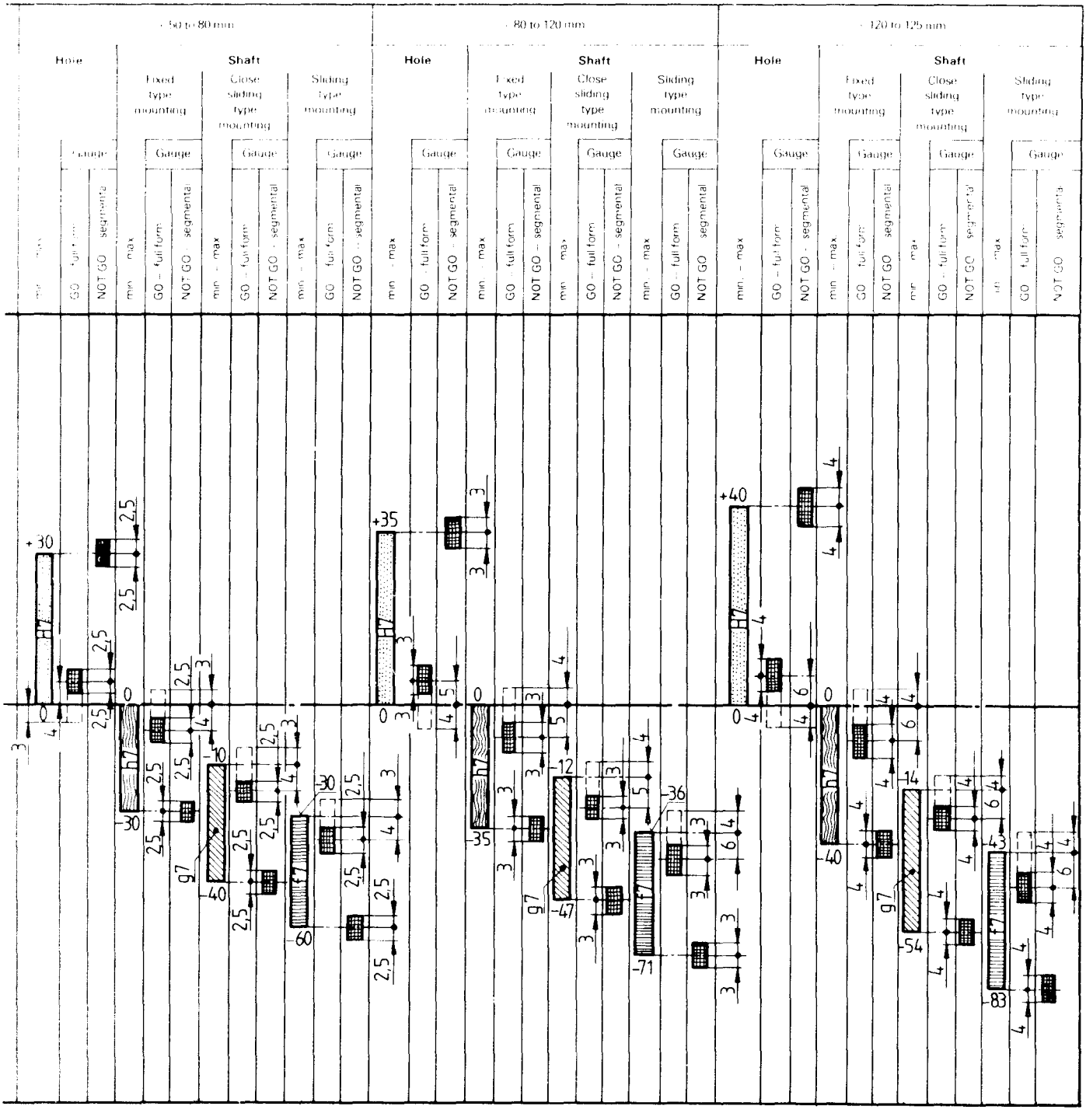
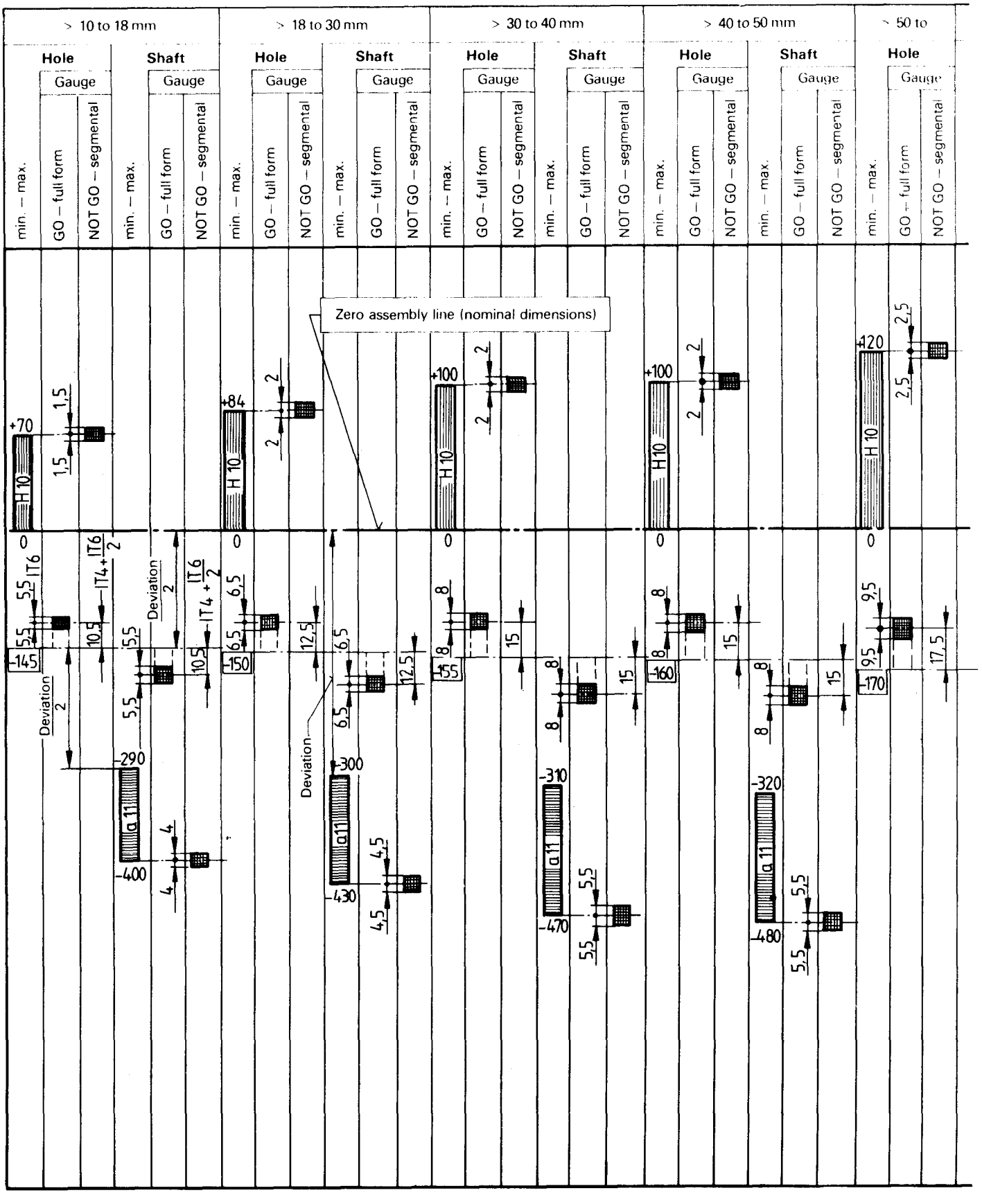
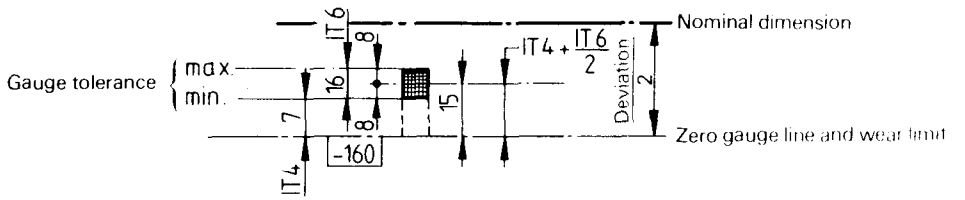


Table 5 — Diameter not

(Tolerances in micrometres)



Example of reading for (hole) GO gauge for dimensions > 40 to 50 mm



ensuring fitting — Major diameter

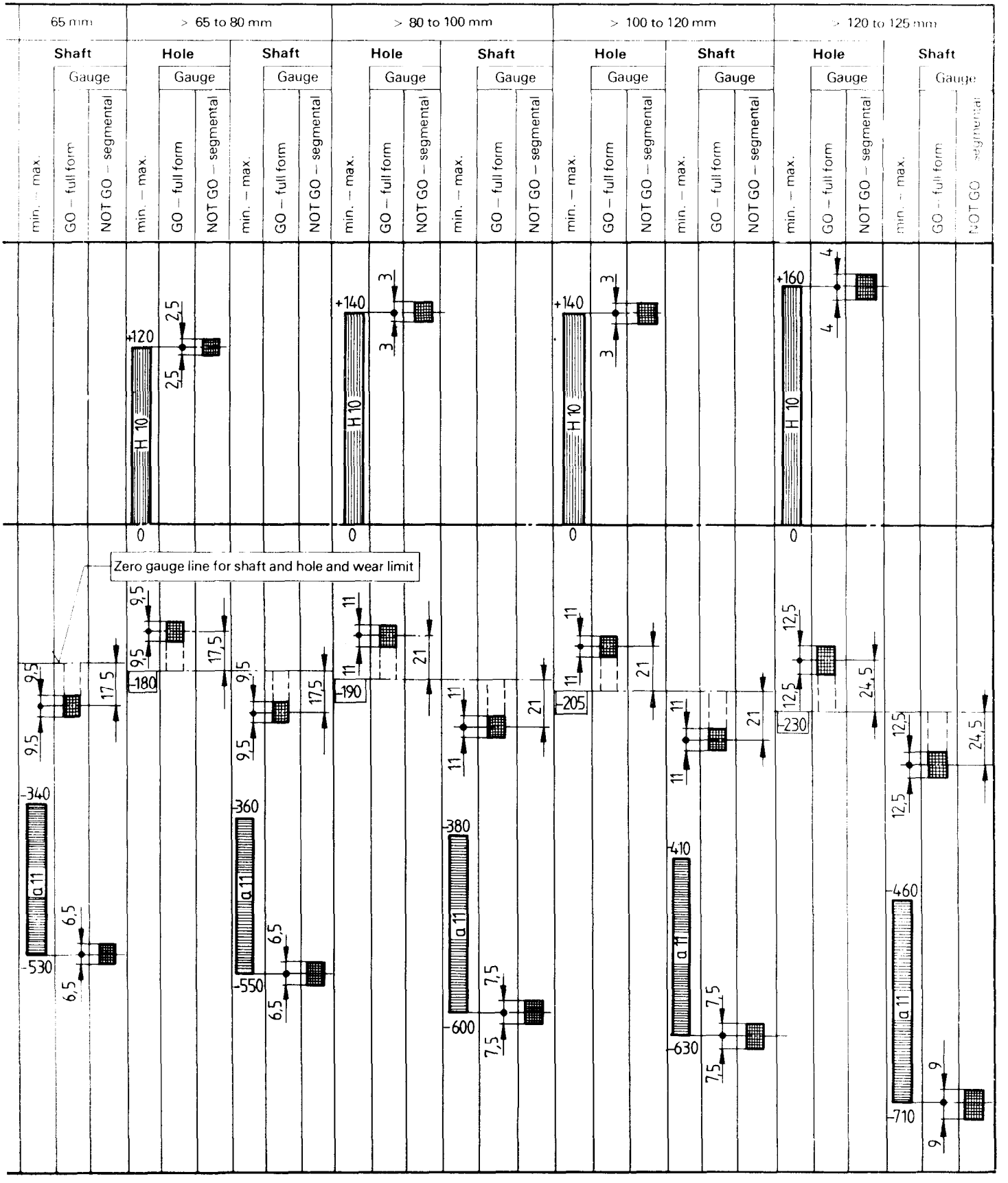
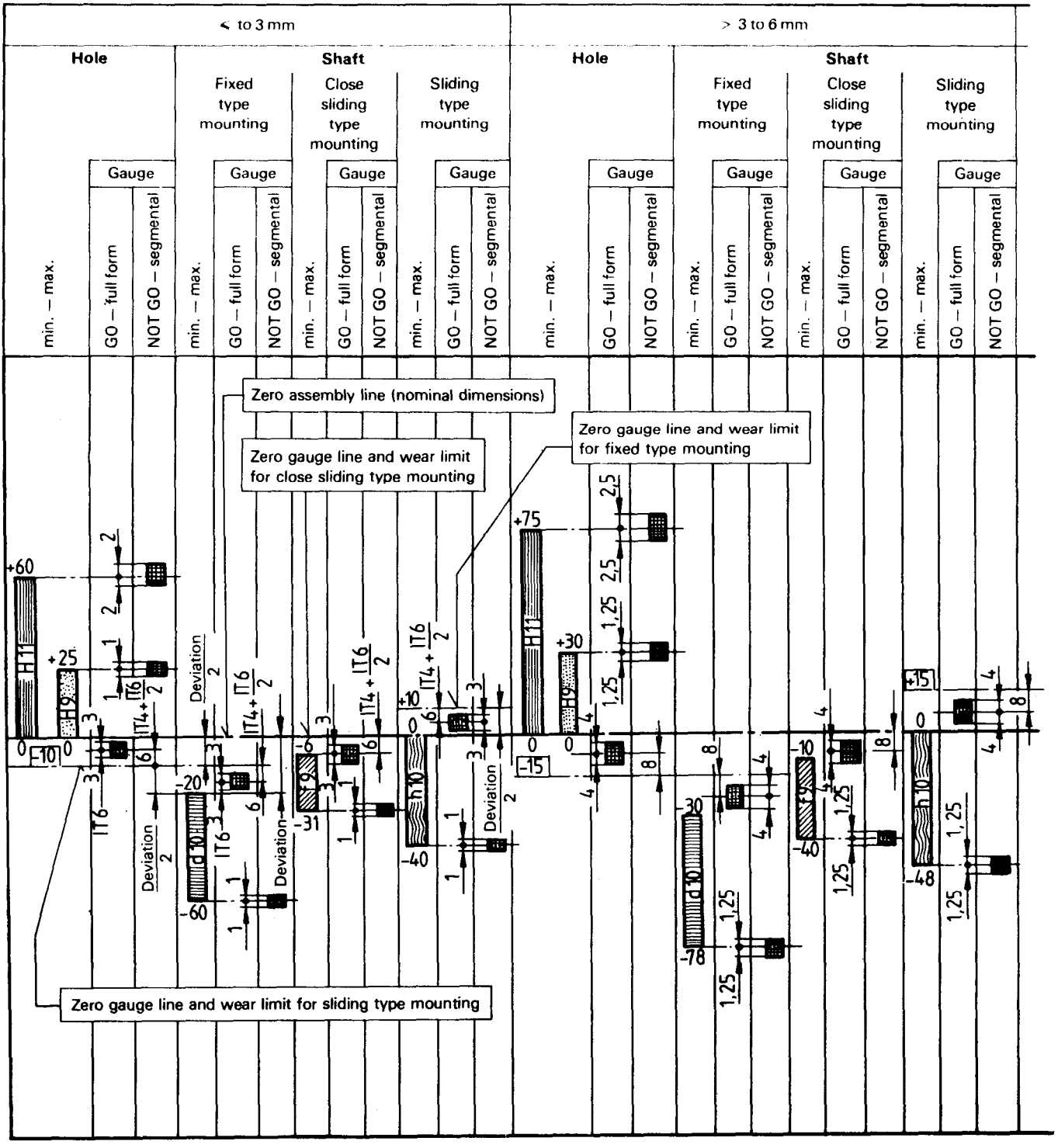


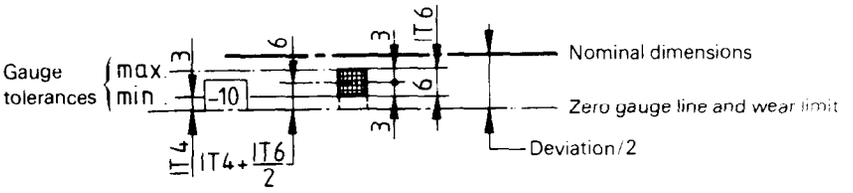
Table 6 – **Widths of splines – Sliding.**

(Tolerances in micrometres)

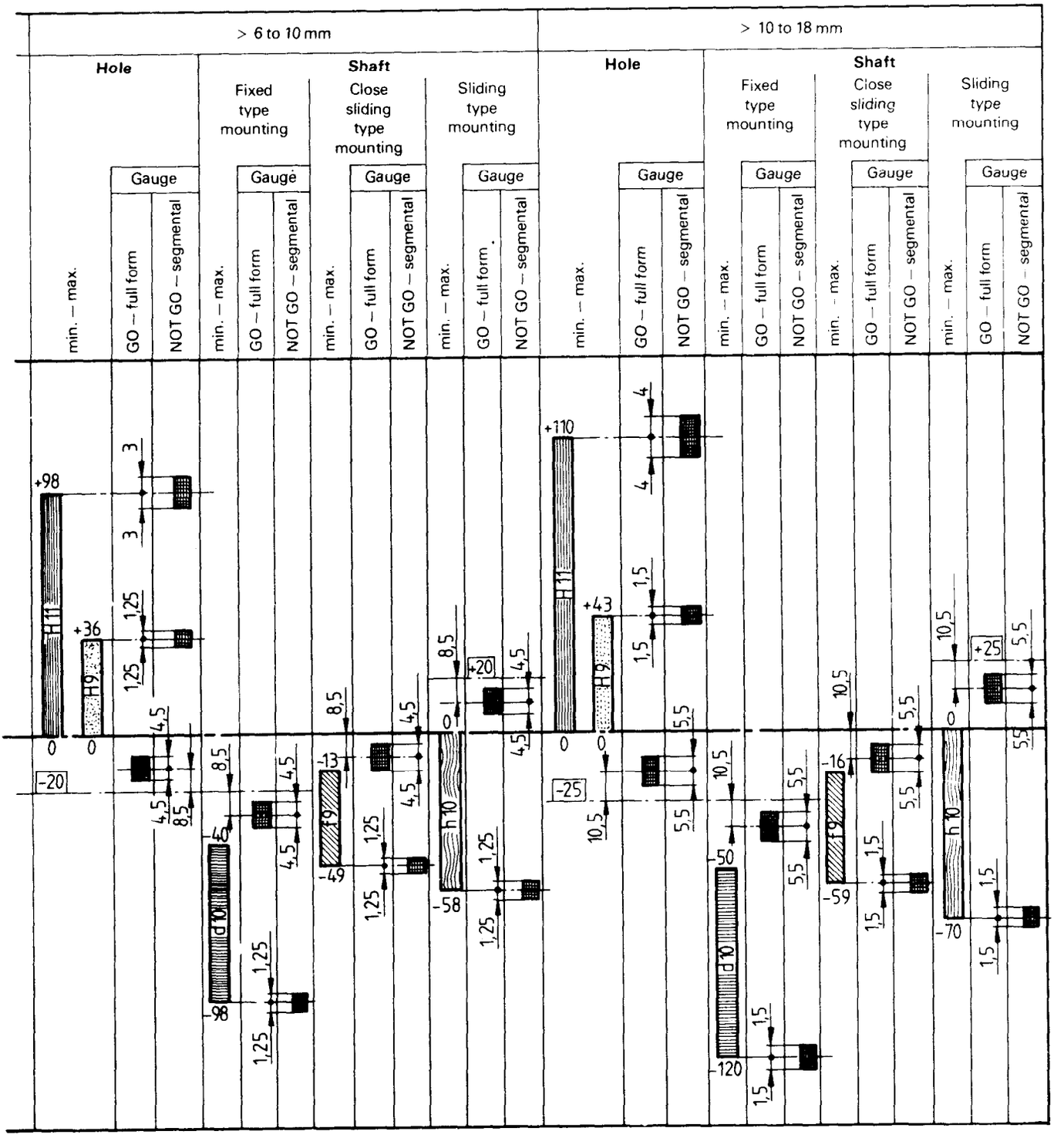


1) For the close sliding mounting, the wear limit of GO gauges (of shaft) has been located at the nominal dimension, without taking the deviation/2 nto account.

Example of reading for (hole) GO for dimensions ≤ 3 (sliding or fixed)[1]



close sliding or fixed type mounting



6.4 Length of gauge measuring part

6.4.1 Measuring part of GO gauges

The length of measuring part of GO (plug or ring) gauges shall be at least equal to the minimum values indicated in table 7 and selected from the R 20 series of preferred numbers.

The shaft GO (ring) gauge is not splined over its whole length and presents a plain cylindrical part, the diameter and tolerances of which have the same values as the major diameter D of the gauge splines.

The hole GO (plug) gauge is splined over its whole length.

NOTE – The hole GO gauge may however present one (or two) plain cylindrical part(s) to ease gauge introduction in the gauged hole.

Table 7 – Measuring part of GO gauges – Minimum length

Dimensions in millimetres

Nominal major diameter D of splines	GO plug gauge (hole)	GO ring gauge (shaft)	
	Minimum length		
	splined	total	splined
14 16	20	20	10
20 22	25	20	10
25 26 28 30	31,5	25	12,5
32 34	40	28	14
36 38 40 42	45	35,5	18
46 48	50	45	22,4
50 54 58 60 62 65	50	50	25
68 72 78 82	50	56	28
88 92 102 108	50	63	31,5
112 120 125	56	71	35,5

6.4.2 Measuring part of NOT GO gauges

The recommended length of the measuring part of NOT GO segmental gauges for holes or shafts has been determined taking into account of the studies undertaken within ISO by Sub-Committee 3, Dimensional metrology of ISO/TC 3 "limits and fits" (ISO 3670) concerning NOT GO plain gauges.

Table 8 – Measuring part of NOT GO segmental gauges – Recommended length

Dimensions in millimetres

Nominal major diameter D of splines	Recommended length of NOT GO segmental gauges (for holes or shafts)
14 16	10
20 22	12
25 26 28 30	14
32 34 36 38 49	15
42 46 48 50 54 58 60 62 65	18
68 72 78 82 88 92 98 102 108	25
112 120 125	25

6.5 Gauge chamfers

On the plugs, the presence of a chamfer may be considered necessary. In no case shall the maximum value of this 45° chamfer exceed the clearance between the shaft and hub to be inspected.

6.6 Plug handles

Handles for plug gauges shall be those commonly intended for plain or screw gauges (see ISO 3670).

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The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

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Doc : No. LM 10 (5051)

Amendments Issued Since Publication

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