INTERNATIONAL STANDARD

ISO 4156

First edition
1981-05-01

AMENDMENT 1
1992-11-01

Straight cylindrical involute splines — Metric module, side fit — Generalities, dimensions and inspection

AMENDMENT 1 : Section three : Inspection

Cannelures cylindriques droites à flancs en développante — Module métrique, à centrage sur flancs — Généralités, dimensions et vérification

AMENDEMENT 1 : Section trois : Vérification

Reference number
ISO 4156 : 1981/Amd.1 : 1992 (E)

Contents

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Amendment 1 to International Standard ISO 4156 : 1981 was prepared by Technical Committee ISO/TC 14, *Shafts for machinery and accessories,* Sub-Committee 2, *Couplings*.

This page intentionally left blank

Straight cylindrical involute splines — Metric module, side fit — Generalities, dimensions and inspection

AMENDMENT 1 : Section three : Inspection

Warning

Some of the symbols used in this addendum could seem to have two meanings. For instance Z means either the number of teeth (as is customary in the ISO Standards for spline or gears) or the distance between the centre of the tolerance zone of new GO gauges for shafts and the GO workpiece limit (see ISO/R 1938).

The authors have not thought it necessary to distinguish them, since the context will always preclude any ambiguity.

Section three : Inspection

15 Scope

This addendum provides guidance and data necessary for the inspection of straight (non-helical) cylindrical involute splines.

16 Reference temperature

The standard reference temperature for industrial length measurements is 20 °C. The dimensional requirements for parts and gauges are defined at that temperature and inspection shall also normally be carried out at that same temperature.

If measurements are taken at another temperature, the results shall be corrected using the expansion coefficients of parts and gauges respectively.

Unless otherwise specified, all measurements shall be made under zero measuring load.

If measurements are made under a non-zero load, the results shall be corrected accordingly. However, such correction is not required for comparison measurements made with the same comparison means and under the same measuring load, between similar components of the same material and with the same surface condition.

17 Inspection with limit gauges

17.1 Introduction

The procedures for inspection of straight cylindrical involute splines are defined below for cases where use is made of limit gauges. However, it is not mandatory to use such gauges and direct measurement is acceptable provided that this method has been agreed by the parties concerned under conditions to be defined so as to meet the requirements of this addendum.

By convention, a part is deemed acceptable when its splines are found satisfactory using gauges meeting the requirements of this addendum, which is the authority for gauging. Consequently, the choice of gauge shall be agreed between customer and manufacturer in the contract, so that, if the customer uses his own gauges for acceptance purposes, they shall be close enough to the prescribed external limits not to reject splines already deemed acceptable by the manufacturer's gauges. In case of dispute, both the manufacturer and the customer shall make their gauges available to each other for checking on their own premises. In the event of a continuing dispute, the gauges shall be referred to a calibration authority recognized by the two parties.

17.2 Inspection methods

Three methods of inspection are provided in table 120, "Positions of gauge tolerances", for gauge inspection of splines :

- the "standard method";
- the "alternative method A";
- the "alternative method B".

The selected method of inspection shall be described explicitly.

These different methods of inspection on the NOT GO side lead to the following conclusions for H/h fit :

Table 117 — Inspection methods

Inspection method[1)]	Theoretical maximum clearance between mating parts (zero-form variation)	Maximum variation of form in each part (zero clearance)
Standard	$2\,(T + \lambda)$	$T + \lambda$
A	$2\,T$	$T + \lambda$
B	$2\,T$	Undetermined

1) In the rest of this addendum, the terms "standard method", "method A" and "method B" are used for simplicity's sake.

For fits other than H/h, the theoretical maximum clearance will vary as a function of the fundamental deviations.

17.2.1 Inspection on the GO side

In the three above-mentioned methods, GO composite gauges are used to check

— that the effective limits of space width or tooth thicknesses are not exceeded on the GO side, to ensure the desired fit;

— the form diameter of the part, thus ensuring that the desired tolerances are respected for the full specified involute depth.

17.2.2 Inspection on the NOT GO side

17.2.2.1 Standard method

In the "standard method", NOT GO sector spline gauges with sector teeth check the actual limits of space width or tooth thickness at the minimum material conditions of the parts.

17.2.2.2 Method A

In "method A", two types of NOT GO gauges are provided :

— one covers NOT GO sector spline gauges which check (as for the "standard method") the actual limits of space width or tooth thickness at the minimum material conditions of the parts;

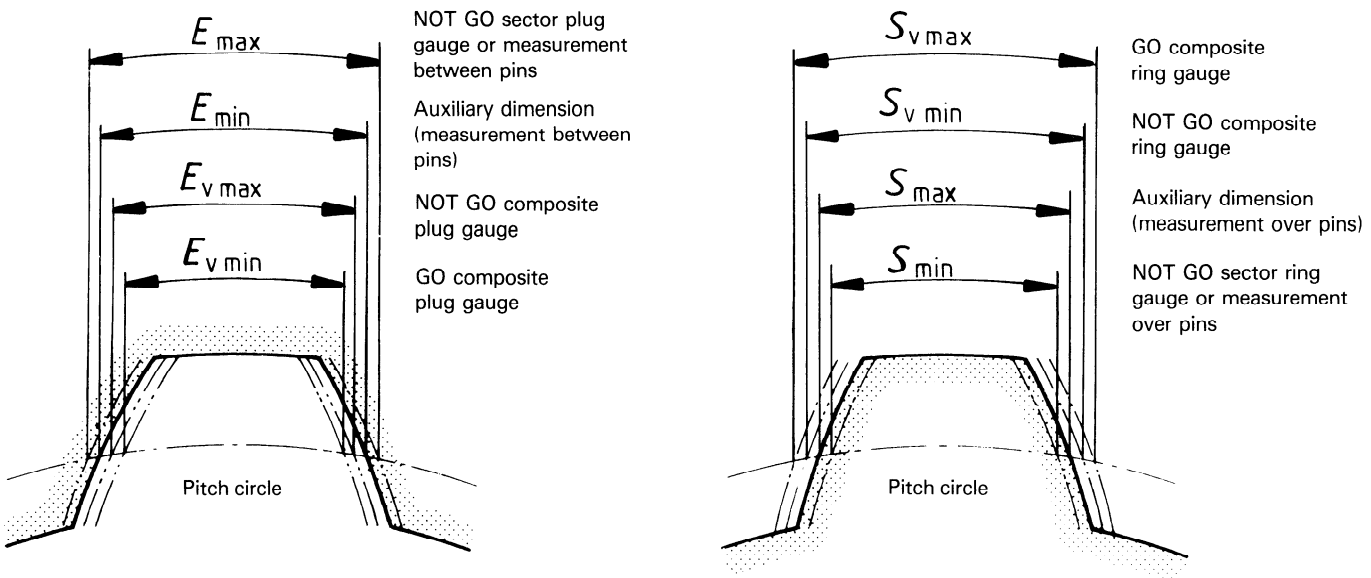
— the other covers NOT GO composite spline gauges which check the effective limits of space width or tooth thickness to ensure the desired conditions of use (variation allowances are in this case checked globally).

17.2.2.3 Method B

In "method B", NOT GO composite gauges check (as for "method A") the effective limits of space width or tooth thickness not to be exceeded on the NOT GO side (the actual limits of space width or tooth thickness at the minimum material condition of parts are not checked in this case).

17.2.2.4 Control using measuring pins or balls

Control using measuring pins or balls is permissible instead of NOT GO sector ring or plug gauges.



a) Internal spline

b) External spline

Figure 16 — Relationship between the dimensions of the parts and gauges used

17.2.3 GO and NOT GO inspection of diameter at tooth top (D_{ii} or D_{ee})

All these inspection methods require measuring the tooth top (internal minor diameter, D_{ii}, or external major diameter, D_{ee}) using GO and NOT GO plain (plug or ring) gauges or other acceptable measuring devices.

17.3 Additional inspection

Checking splines using a GO composite spline (plug or ring) gauge does not identify, if a part is rejected by the gauge, the defective dimensional elements causing the rejection.

If such cases are required to be reported, additional inspection (specifically instructed) must be made by analytical inspection (see clause 23) of separate dimensional measurement of actual space width or tooth thickness using two balls or pins, total cumulative pitch variation, total profile variation, and lead variation.

The choice between balls or pins for space width or tooth thickness measurement shall be specified.

Because of the difference in flank contact and of spline tooth lead variations or surface condition, measuring balls and pins will probably not provide the same measurement results for space width or tooth thickness.

17.4 Influence of the "active spline length" and of the "length of engagement" [see figure 17, a) and b)]

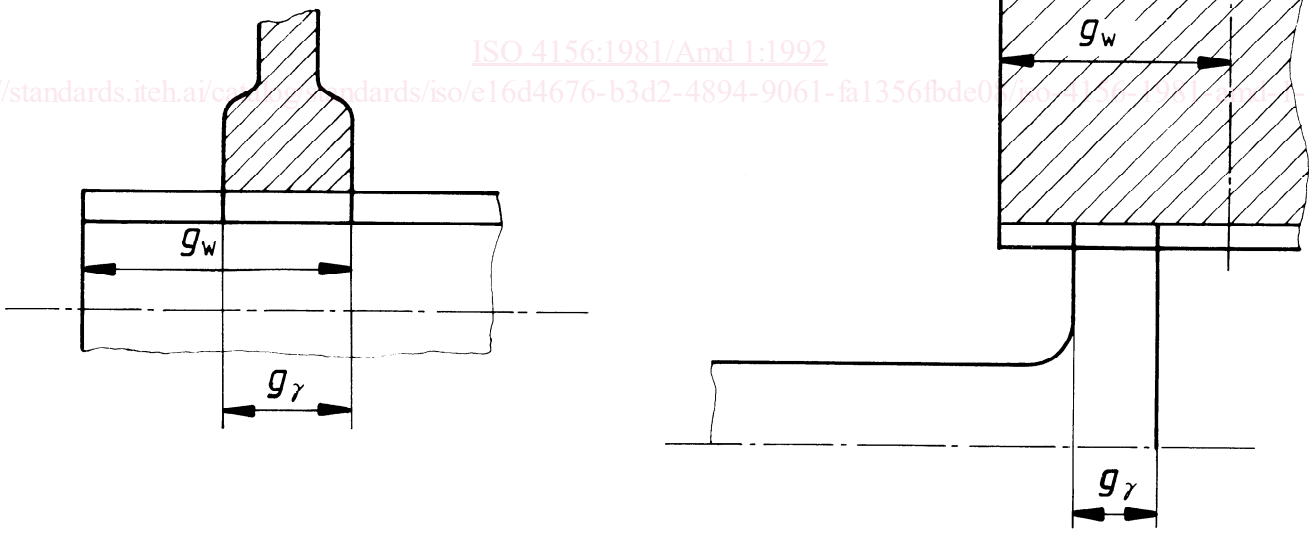
The definitions of length of engagement, g_γ, and of active length, g_w, are given in clause 2.

Since check gauges are often shorter than the parts to be checked, the "active length" and "length of engagement" may influence the maximum permissible alignment of splines (parallelism error of the splines with respect to the axis).

If the "length of engagement" is smaller than or equal to half the pitch diameter, and if the "active length" is equal to the "length of engagement", alignment variations of splines can generally, unless otherwise specified, be included in the total tolerances $(T + \lambda)$ (defined in clause 6), and checked simultaneously by limit gauges according to the inspection methods specified in 17.2.1, 17.2.2 and 17.2.3.

In the case where the "length of engagement" is greater than half the pitch diameter and the "active length" is greater than or equal to the "length of engagement", it might be necessary to prescribe spline alignment tolerances independent of the total tolerance $(T + \lambda)$; these tolerances may then have to be checked separately by "analytical inspection".

If particular spline alignment tolerances are specified, account should be taken that they should generally be proportionally all the smaller since the "active length" or the "length of engagement" or both will be greater.



a) Shaft longer than hole

b) Hole longer than shaft

Figure 17 — Active length and length of engagement

17.5 Conditions for use of gauges

17.5.1 GO side

GO composite gauges (spline ring or plug) shall pass over the specified spline length without forcing. The gauge weight or a specified load may be used.

A small movement may be imparted to the gauge in order to minimize the effects of friction.

17.5.2 NOT GO side

NOT GO gauges are used in the same way as the gauges for checking plain cylindrical parts; checking is made at least in three angular positions as equally distributed as possible.

17.6 Limiting dimensions of use for gauges

Practical use for gauges is limited by gauge weight and dimensions.

Parts with a pitch diameter $D \leqslant 180$ mm can normally be checked by limit gauges.

Parts with a pitch diameter $D > 180$ mm can be checked by limit gauge only if agreed between the customer and the supplier. Wherever possible, the weight of the gauge shall not exceed 10 kg.

17.7 Inspection of gauges

17.7.1 Dimensional inspection

17.7.1.1 The actual dimensions of composite or sector spline plug gauges are normally checked by direct measurement and by balls or plain cylindrical pins. The choice between balls or pins checking shall be specified explicitly and checking shall involve all tooth spaces.

It should be noted that due to their geometry, measuring balls or pins do not integrate the defects of checked parts in an equivalent manner, especially surface condition or lead variations.

17.7.1.2 The dimensions of composite or sector splines ring gauges are normally checked by "master" composite plug gauges and by balls or plain cylindrical pins.

"Master" plug gauges are tapered on one side of all teeth and are themselves normally checked by direct measurement and by balls in well-defined planes.

17.7.1.3 Plain (ring or plug) gauges are checked in the same conditions as those gauges used for plain cylindrical part inspection.

17.7.2 Inspection of gauge variation allowance

Gauges may show total index variations, total profile variation, and lead variation.

If these variations should be checked, this can be done by "analytical inspection" (see clause 23) which allows inspection of each variation separately. In principle, analytical inspection only applies to plug gauges or "master" plug gauges. It can apply to ring gauges only in the case where no "master" plug gauge is available for checking.

It should be noted that this analytical inspection of ring gauges is more severe than inspection by "master" plug gauge because of the fact that variation allowances are inspected independently of dimensions, which may lead at the maximum material condition limits to the rejection of ring gauges which would otherwise have been accepted by a "master" plug gauge.

18 Manufacturing tolerances for spline gauges

This addendum specifies a unique grade for spline gauges, based upon the spline tolerance class 6.

Manufacturing tolerances for GO and NOT GO gauges and for wear limits on the GO side are given in tables 118 to 121.

NOTES

1 Tables 118 to 121 concern especially actual limits of gauge space width or gauges tooth thickness.

2 Form errors of gauges are always independent of dimensional tolerances. Their individual values are indicated in table 124 and their cumulated values (E, E_1) in tables 118 to 121.

3 In the limiting cases where gauges are manufactured at the maximum material condition, form errors lead to a displacement of the limits of acceptance of the parts.

18.1 Positions of tolerance zone and wear limits in relation to the limits of the part to be checked

The relative positions are shown in terms of diagrams in table 120.

NOTE — A wear limit is required and provided only for GO gauges.

18.2 Values for gauge tolerances

The definition of the range of the dimensional tolerance zone for space width and tooth thickness of gauges is based on the same principle as for the total tolerance ($T + \lambda$) of the parts in tolerance class 6 (see clause 6).

Gauge tolerances are based on the ISO fundamental tolerances (IT) of grades 3 to 5, as given in table 118.

Table 118 — Manufacturing tolerances for gauges — Unique grade

Unique tolerance grade applicable to parts of tolerance class	Tolerance qualities of part	Tolerances for plug gauges				Tolerances for ring gauges			
		H^*	E^{***}	Z^{**}	Y^{****}	H_1^*	E_1^{***}	Z_1^{**}	Y_1^{****}
4	IT6* + IT9**	GO plug gauge				GO ring gauge			
5	IT7* + IT10**	IT3	—	IT5	$\frac{IT3}{2}$	IT4	—	IT5	$\frac{IT4}{2}$
6	IT8* + IT11**	NOT GO plug gauge				NOT GO ring gauge			
7	IT9* + IT12**	IT3	—	—	—	IT4	—	—	—

* Tolerance based on pitch diameter.

** Tolerance based on theoretical space width or tooth thickness, see note 2 below.

*** For the calculation of E and E_1, see note 1 below.

**** $Y = H/2$ and $Y_1 = H_1/2$; tolerance based on pitch diameter, see note 3 below.

NOTES

1 Values given for H and H_1 (dimensional tolerances of the gauges) are in accordance with those given in ISO/R 1938, *ISO system of limits and fits — Part 2 : Inspection of plain workpieces.*

E and E_1 (cumulative form tolerances of the gauges) are calculated from the equation :

$$E \text{ or } E_1 = 0{,}6\sqrt{(\text{profile variation})^2 + (\text{index variation})^2 + (\text{lead variation})^2}$$

applied to table 124, taking account of the measuring length of gauges given in tables 122 and 123. The values of E and E_1 given in table 121 are rounded values.

2 The values given for Z and Z_1 (corresponding to the position of the GO gauge tolerance zone, in relation to the GO limit of the workpiece; see table 120) are the part of the gauge tolerance which is based on the theoretical space width or tooth thickness.

3 The values given for Y and Y_1 (corresponding to the displacement, outside the GO workpiece limit, of the wear limit of gauge; see table 120) have been selected respectively equal to $H/2$ and $H_1/2$.

18.3 Special provisions

18.3.1 If agreed between customer and manufacturer, gauges of grades other than the unique grade can be created, in accordance with ISO/R 1938 and taking account of the tolerance class of the part to be checked, as shown in table 119.

Table 119 — Manufacturing tolerances for gauges — Grades other than the unique grade

Tolerance grades applicable to parts of tolerance class	Tolerance qualities of the part	Tolerances for plug gauges				Tolerances for ring gauges			
		H^*	E^{***}	Z^{**} *****	Y^{****} *****	H_1^*	E_1^{***}	Z_1^{**} *****	Y_1^{****} *****
4	IT6* + IT9**	IT2	—	IT3	$\frac{IT2}{2}$	IT3	—	IT4	$\frac{IT3}{2}$
5	IT7* + IT10**	IT3	—	IT3	$\frac{IT3}{2}$	IT3	—	IT4	$\frac{IT3}{2}$
6	IT8* + IT11**	IT3	—	IT5	$\frac{IT3}{2}$	IT4	—	IT5	$\frac{IT4}{2}$
7	IT9* + IT12**	IT3	—	IT5	$\frac{IT3}{2}$	IT4	—	IT5	$\frac{IT4}{2}$

* Tolerance based on pitch diameter.

** Tolerance based on theoretical space width or tooth thickness, see note 2 in 18.2.

*** For the calculation of E and E_1, see note 1 in 18.2.

**** $Y = H/2$ and $Y_1 = H_1/2$; tolerance based on pitch diameter, see note 3 in 18.2.

***** For GO gauges only.

18.3.2 Spline gauges with a pitch diameter $D > 180$ mm shall be created according to the same rules as stated above.

However, for the part of the gauge tolerance based on the pitch diameter, a shift of the NOT GO gauge tolerance zone and of the wear limit of the GO gauge with respect to the checked limits of pieces shall be taken into account.

The shift, for which values α for plug gauges and α_1 for ring gauges are given in ISO/R 1938, is intended to compensate measuring uncertainties of gauges.

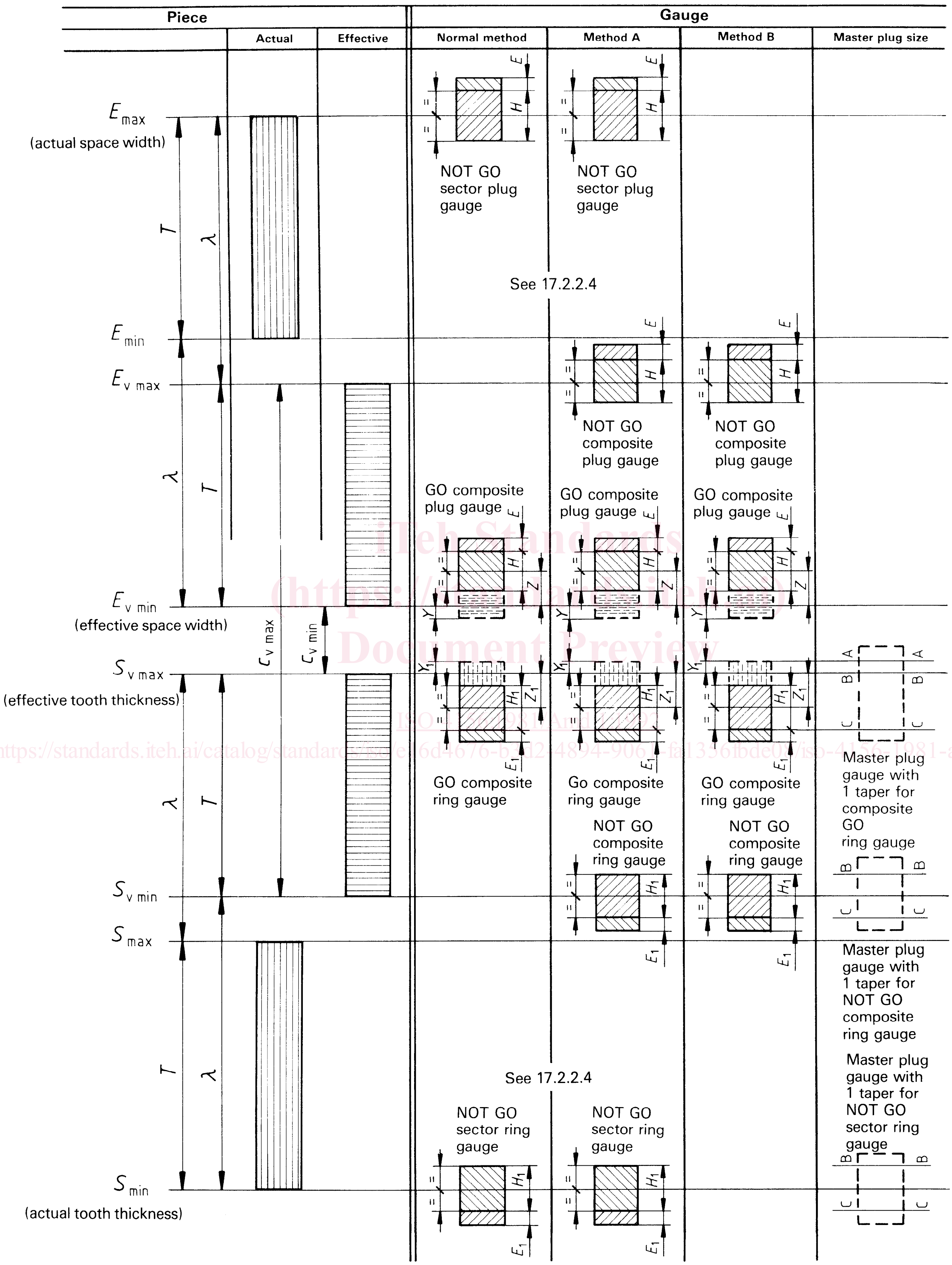

Piece
Gauge
Actual
Effective
Normal method
Method A
Method B
Master plug size
E_{max}
(actual space width)
E_{min}
$E_{v\ max}$
$E_{v\ min}$
(effective space width)
$C_{v\ max}$
$C_{v\ min}$
$S_{v\ max}$
(effective tooth thickness)
$S_{v\ min}$
S_{max}
S_{min}
(actual tooth thickness)
T
λ
NOT GO sector plug gauge
NOT GO sector plug gauge
See 17.2.2.4
NOT GO composite plug gauge
NOT GO composite plug gauge
GO composite plug gauge
GO composite plug gauge
GO composite plug gauge
GO composite ring gauge
Go composite ring gauge
GO composite ring gauge
NOT GO composite ring gauge
NOT GO composite ring gauge
Master plug gauge with 1 taper for composite GO ring gauge
Master plug gauge with 1 taper for NOT GO composite ring gauge
Master plug gauge with 1 taper for NOT GO sector ring gauge
See 17.2.2.4
NOT GO sector ring gauge
NOT GO sector ring gauge
E
H
Z
Y
Y_1
H_1
Z_1
E_1
A
B
C

Table 120 — Positions of gauge tolerances

Table 121 — Values of dimensional tolerances of spline gauges for the recommended grade

Tolerances in micrometres

Pitch diameter D mm	GO and NOT GO plug gauges					GO and NOT GO ring gauges				
	Tolerance	Theoretical circular space width, E (mm)				Tolerance	Theoretical circular tooth thickness, S (mm)			
		$0 < E \leqslant 3$	$3 < E \leqslant 6$	$6 < E \leqslant 10$	$10 < E \leqslant 18$		$0 < S \leqslant 3$	$3 < S \leqslant 6$	$6 < S \leqslant 10$	$10 < S \leqslant 18$
$1 \leqslant D \leqslant 3$	H	2				H_1	3			
	E	5				E_1	5			
	Z	4				Z_1	4			
	Y	1				Y_1	1,5			
$3 < D \leqslant 10$	H	2,5				H_1	4			
	E	5				E_1	5			
	Z	4				Z_1	4			
	Y	1,25				Y_1	2			
$10 < D \leqslant 18$	H	3	3			H_1	5	5		
	E	5	5			E_1	5	5		
	Z	4	5			Z_1	4	5		
	Y	1,5	1,5			Y_1	2,5	2,5		
$18 < D \leqslant 30$	H	4	4	4		H_1	6	6	6	
	E	5	5	5		E_1	5	5	5	
	Z	4	5	6		Z_1	4	5	6	
	Y	2	2	2		Y_1	3	3	3	
$30 < D \leqslant 50$	H	4	4	4	4	H_1	7	7	7	7
	E	5	5	5	5	E_1	5	5	5	5
	Z	4	5	6	8	Z_1	4	5	6	8
	Y	2	2	2	2	Y_1	3,5	3,5	3,5	3,5
$50 < D \leqslant 80$	H	5	5	5	5	H_1	8	8	8	8
	E	5	5	5	5	E_1	5	5	5	5
	Z	4	5	6	8	Z_1	4	5	6	8
	Y	2,5	2,5	2,5	2,5	Y_1	4	4	4	4
$80 < D \leqslant 100$	H	6	6	6	6	H_1	10	10	10	10
	E	5	5	5	5	E_1	5	5	5	5
	Z	4	5	6	8	Z_1	4	5	6	8
	Y	3	3	3	3	Y_1	5	5	5	5
$100 < D \leqslant 120$	H	6	6	6	6	H_1	10	10	10	10
	E	6	6	6	6	E_1	6	6	6	6
	Z	4	5	6	8	Z_1	4	5	6	8
	Y	3	3	3	3	Y_1	5	5	5	5
$120 < D \leqslant 150$	H	8	8	8	8	H_1	12	12	12	12
	E	6	6	6	6	E_1	6	6	6	6
	Z	4	5	6	8	Z_1	4	5	6	8
	Y	4	4	4	4	Y_1	6	6	6	6
$150 < D \leqslant 180$	H	8	8	8	8	H_1	12	12	12	12
	E	7	7	7	7	E_1	7	7	7	7
	Z	4	5	6	8	Z_1	4	5	6	8
	Y	4	4	4	4	Y_1	4	4	4	4
	Corresponding standardized modules (mm)									
		0,25 0,5 0,75 1 1,25 1,5 1,75	2 2,5 3	4 5 6	8 10		0,25 0,5 0,75 1 1,25 1,5 1,75	2 2,5 3	4 5 6	8 10

19 Length of measuring part of gauges

19.1 GO or NOT GO gauges

The values given for the minimum length of the measuring part of GO or NOT GO plain or spline gauges are those in ISO 3670, *Blanks for plug gauges and handles (taper lock and trilock) and ring gauges — Design and general dimensions.*

The length of the composite GO gauges shall comply with ISO 3670. In the case where the length of engagement is greater than 1,5 times the value given in tables 122 or 123, the active length of the GO composite spline plug or ring gauge should be increased. A gauge length of 75 % of the length of engagement is usually satisfactory. This shall be subject to prior agreement between purchaser and manufacturer.

NOTE — GO and NOT GO spline gauges may include a non-measuring part (plain cylindrical part or chamfer) intended for making gauge entrance easier.

Table 122 — Measuring part of ring gauges — Minimum length

Dimensions in millimetres

Pitch diameter of splines D	Minimum length of spline or plain ring gauges	
	GO	NOT GO
$1 \leqslant D \leqslant 2{,}5$	6	4
$2{,}5 < D \leqslant 5$	10	5
$5 < D \leqslant 10$	12	8
$10 < D \leqslant 15$	14	10
$15 < D \leqslant 20$	16	12
$20 < D \leqslant 25$	18	14
$25 < D \leqslant 32$	20	16
$32 < D \leqslant 40$	24	18
$40 < D \leqslant 50$	32	20
$50 < D \leqslant 60$	32	20
$60 < D \leqslant 70$	32	24
$70 < D \leqslant 80$	32	24
$80 < D \leqslant 90$	32	24
$90 < D \leqslant 100$	32	24
$100 < D \leqslant 110$	40	24
$110 < D \leqslant 120$	40	24
$120 < D \leqslant 140$	45	24
$140 < D \leqslant 180$	50	30

Table 123 — Measuring part of plug gauges — Minimum length

Dimensions in millimetres

Pitch diameter of splines D	Minimum length of spline or plain plug gauges	
	GO	NOT GO
$1 \leqslant D \leqslant 3$	6,5	4,5
$3 < D \leqslant 6$	8	6
$6 < D \leqslant 10$	10	7
$10 < D \leqslant 14$	12	8
$14 < D \leqslant 18$	14	10
$18 < D \leqslant 24$	16	12
$25 < D \leqslant 30$	18	14
$30 < D \leqslant 40$	20	15
$40 < D \leqslant 50$	25	18
$50 < D \leqslant 65$	30	18
$65 < D \leqslant 80$	35	25
$80 < D \leqslant 90$	35	25
$90 < D \leqslant 95$	35	25
$95 < D \leqslant 100$	35	25
$100 < D \leqslant 110$	35	25
$110 < D \leqslant 120$	40	25
$120 < D \leqslant 140$	45	30
$140 < D \leqslant 180$	50	30

19.2 Tapered tooth master plug gauges

19.2.1 GO master gauges

The length of the measuring part of the GO master plug gauge shall be determined taking into account the following cumulative elements :

a) a lead length corresponding to the minimum length of the measuring part of the checked GO ring;

b) a checking length, function of the mating side taper of the GO master plug gauge (see 17.7.1.2) and of the range of the dimensional tolerance of the checked GO ring;

c) a wear length, function of the side taper of the GO master plug gauge and of the range of the wear tolerance of the checked GO ring.

19.2.2 NOT GO master gauges

The length of the measuring part of the NOT GO master plug gauge (composite or sector) shall be determined based on the following cumulative elements:

a) a lead length, corresponding to the minimum length of the measuring part of the checked NOT GO ring;

b) a checking length, function of the mating side taper of the NOT GO master plug gauge and of the range of the dimensional tolerance of the checked NOT GO ring.

19.3 Spline gauges of pitch diameters $D > 180$ mm

For spline gauges having a pitch diameter $D > 180$ mm it is advisable to choose a measuring length equal to

— 30 % of the pitch diameter for GO gauges;

— 20 % of the pitch diameter for NOT GO gauges.

20 Grips of spline gauges

The grips of spline gauges shall be those currently permitted in ISO 3670 for plain or threaded gauges of similar dimensions.

Plug gauges of pitch diameter $D \leqslant 50$ mm may be integral.

21 Values of variation allowances of spline gauges

The variations of form checked on spline gauges are the same as those checked on corresponding parts, i.e. :

— total cumulative pitch variation (index variations);

— total profile variation;

— total lead variation.

Whatever the accuracy of the gauge, the values accepted for variation allowances are those indicated in table 124.

NOTE — GO spline gauges may show a plain cylindrical thoroughly machined proof diameter intended for possible inspection of the radial run-out of the gauge teeth and the product run-out (after the part has been mounted on the gauge).

Table 124 — Variation allowances of spline gauges

Tolerances in micrometres

Pitch diameter D mm	Total profile variation (see 23.2.2)	Total index variation (see 23.2.1)	Total lead variation for a measuring length of the gauge		Radial run-out (see note)	
			less than or equal to 25 mm (see 23.2.3)	greater than 25 mm (see 23.2.3)	Ring	Plug
$D \leqslant 100$	5	5	3	5	10	7
$100 < D \leqslant 150$	5	8	3	5	15	10
$150 < D \leqslant 180$	5	10	—	5	15	10

NOTE — Inspection made with respect to the centre line for plugs, with respect to a cylindrical external band for rings. The cumulative amount of profile variation, index variation and lead variation is given by the value E or E_1 (see note 1 in 18.2).

21.1 Cumulation of variation allowances

The cumulation of gauge variation allowances shall be considered as follows (see figure 18).

— On the control circle, the envelope of the total profile variation measured over 360° and defined by arc AB shall always lie within the envelope of the total index variation measured over 360° and defined by arc CD.

— The lead variation shall be checked independently of all the above-mentioned variations, over the whole measuring length of the gauge at the control circle level.

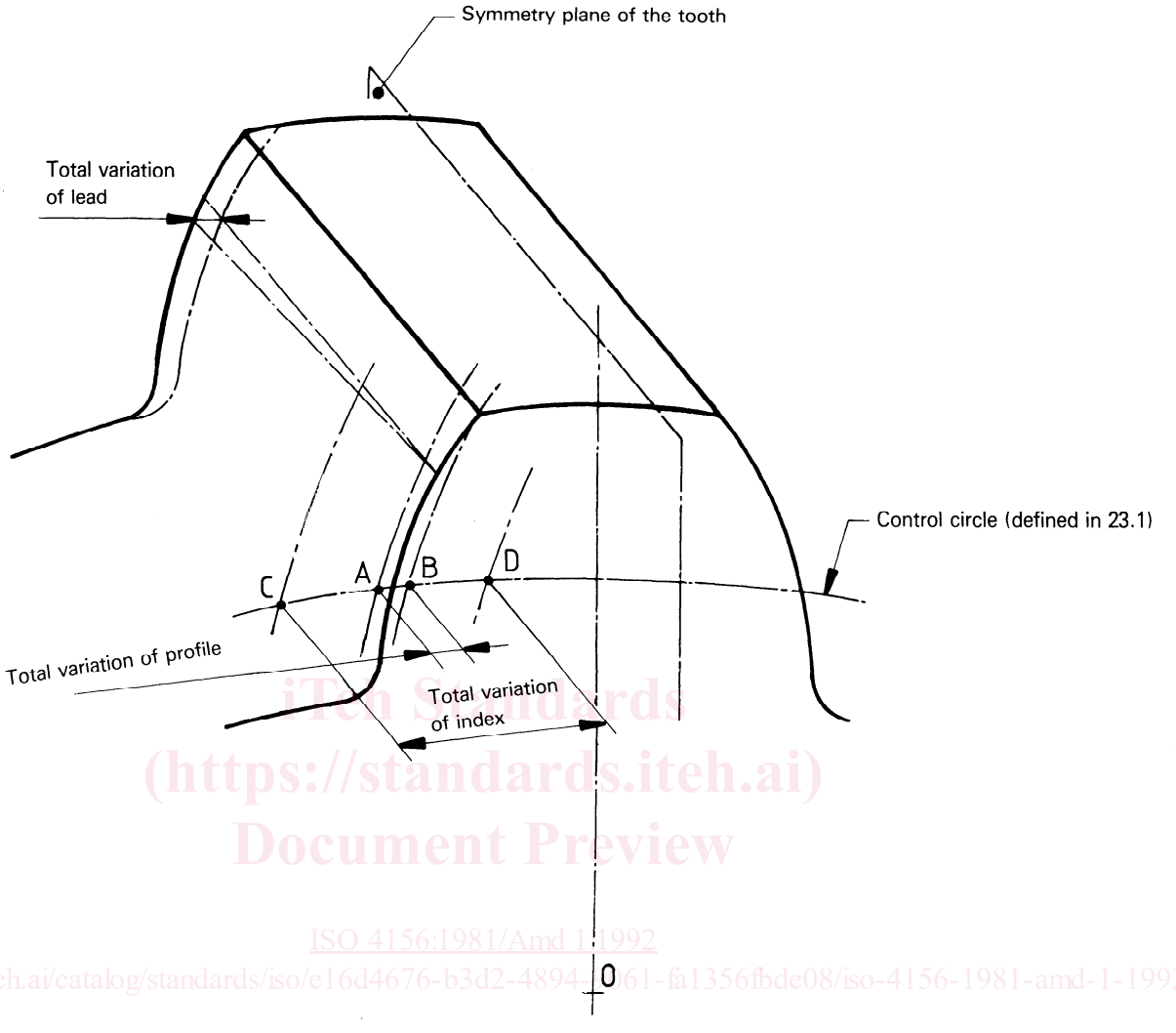


Figure 18 — Cumulation of gauge variation allowances

21.2 Spline gauges of pitch diameters $D > 180$ mm

For spline gauges having a pitch diameter $D > 180$ mm it is advisable to choose the following values for the variation allowances :

- total profile variation : 7 µm
- total index variation : 12 µm
- total lead variation : 8 µm

For cumulated variation allowances, see clause 21.1.

22 Dimensions, designation and marking of gauges

The dimensions, designation and marking of gauges are specified in 22.1 to 22.3.