International Standard 965/1

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION•МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ•ORGANISATION INTERNATIONALE DE NORMALISATION

ISO general purpose metric screw threads — Tolerances — Part 1 : Principles and basic data

Filetages métriques ISO pour usages généraux — Tolérances — Partie 1 : Principes et données fondamentales

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Descriptors : screw threads, ISO screw threads, metric system, nuts (fasteners), screws, designation, dimensions, tolerances, dimensional tolerances, specifications.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up 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.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 965/1 was developed by Technical Committee ISO/TC 1, *Screw threads*, and was circulated to the member bodies in January 1979.

It has been approved by the member bodies of the following countries :

Australia	Germany, F. R.	Norway
Austria	Hungary	Poland
Belgium	India	Romania
Bulgaria	Ireland	South Africa, Rep. of
Canada	Italy	Spain
Chile	Japan	Sweden
China	Korea, Dem. P. Rep. of	Switzerland
Czechoslovakia	Korea, Rep. of	United Kingdom
Denmark	Libyan Arab Jamahiriya	USA
Egypt, Arab Rep. of	Mexico	USSR
Finland	Netherlands	
France	New Zealand	

No member body expressed disapproval of the document.

This second edition cancels and replaces the first edition (i.e. ISO 965/1-1973).

Printed in Switzerland

This International Standard is one of a number of ISO publications determining tolerances for ISO metric screw threads. The complete set is made up as follows :

ISO 965/1, *ISO general purpose metric screw threads — Tolerances — Part 1 : Principles and basic data.*

ISO 965/2, *ISO general purpose metric screw threads — Tolerances — Part 2 : Limits of sizes for general purpose bolt and nut threads — Medium quality.*

ISO 965/3, *ISO general purpose metric screw threads — Tolerances — Part 3 : Deviations for constructional threads.*

ISO/R 1501, *ISO miniature screw threads.*

ISO general purpose metric screw threads — Tolerances — Part 1 : Principles and basic data

1 Scope and field of application

This International Standard specifies a tolerance system for screw threads conforming to ISO 261, *ISO general purpose metric screw threads — General plan.*

The tolerance system refers to the basic profile according to ISO 68, *ISO general purpose screw threads — Basic profile.*

2 References

ISO 898/1, *Mechanical properties of fasteners — Part 1 : Bolts, screws and nuts.*

ISO 965/3, *ISO general purpose metric screw threads — Tolerances — Part 3 : Deviations for constructional threads.*

ISO 1502, *ISO general purpose metric screw threads — Gauging.*

3 Structure of the tolerance system

The system gives tolerances defined by tolerance grades and tolerance positions and a selection of grades and positions.

The system provides for :

a) A series of *tolerance grades* for each of the four screw thread diameters, as follows :

	Tolerance grades
Minor diameter of nut threads (D_1)	4, 5, 6, 7, 8
Major diameter of bolt threads (d)	4, 6, 8
Pitch diameter of nut threads (D_2)	4, 5, 6, 7, 8
Pitch diameter of bolt threads (d_2)	3, 4, 5, 6, 7, 8, 9

Details of tolerance grades and combinations of tolerance grades for pitch and crest diameters according to tolerance quality and length of engagement group required, with an order of preference, are shown in clause 12.

b) Series of *tolerance positions*, G and H for nut threads and e, f, g and h for bolt threads. The established tolerance positions comply with the need of current coating thicknesses and with the demands of easy assembly.

c) *Selection* of recommended combinations of grades and positions (*tolerance classes*) giving the commonly used tolerance qualities Fine, Medium and Coarse for the three groups of length of thread engagement Short, Normal and Long. Moreover a *further selection of tolerance classes* is given for commercial bolt and nut threads. Tolerance classes other than those shown in clause 12 are not recommended and shall only be used for special cases.

4 Terminology and symbols

4.1 Terminology

The term "bolt threads" is used for external screw threads, the term "nut threads" for internal screw threads.

4.2 Symbols

The following symbols are used :

Symbol	Explanation
D	basic major diameter of nut thread
D_1	basic minor diameter of nut thread
D_2	basic pitch diameter of nut thread
d	basic major diameter of bolt thread
d_1	basic minor diameter of bolt thread
d_2	basic pitch diameter of bolt thread
P	pitch
H	height of fundamental triangle
R	bolt root radius
S	designation for thread engagement group Short
N	designation for thread engagement group Normal
L	designation for thread engagement group Long
T	tolerance
T_{D_1}, T_{D_2} T_d, T_{d_2}	tolerances for D_1, D_2, d, d_2
ei, EI	lower deviations
es, ES	upper deviations

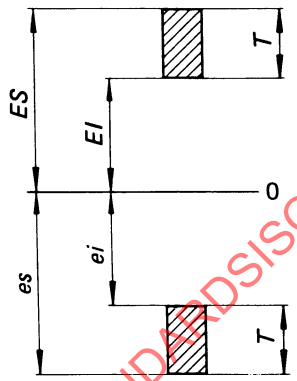


Figure 1 — Position of tolerances with respect to zero line (basic size)

5 Designation

The complete designation for a screw thread comprises a designation for the thread system and size and a designation for the thread tolerance class.

The thread designations appear in the International Standards for ISO general purpose metric screw threads.

The tolerance class designation comprises a class designation for the pitch diameter tolerance followed by a class designation for the crest diameter tolerance.

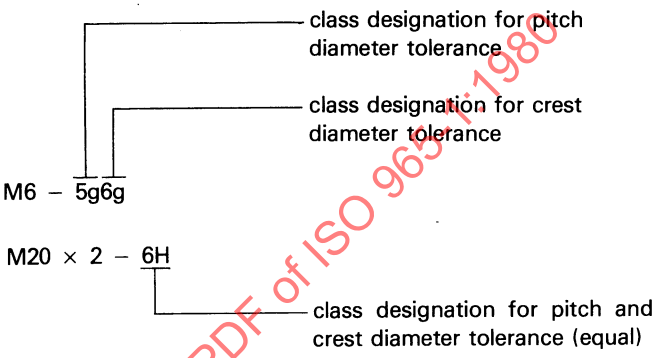
Each class designation consists of

— a figure indicating the tolerance grade;

— a letter indicating the tolerance position, capital for nuts, small for bolts.

If the two class designations for a thread are the same, it is not necessary to repeat the symbols.

Examples :



If considered necessary, the designation for the group of length of thread engagement may be added to the class designation.

A fit between threaded parts is indicated by the nut thread tolerance class followed by the bolt thread tolerance class separated by a stroke.

Examples :

M6 – 6H/6g

M20 × 2 – 6H/5g6g

For coated threads, the tolerances apply to the parts *before* coating, unless otherwise stated. After coating, the actual thread profile shall not in any point transgress the maximum material limits for position H or h respectively.

NOTE — These provisions are intended for thin coatings, for example those obtained by electroplating. For thicker coatings, for example those obtained by hot-dip galvanizing, special provisions are under consideration and will be added to ISO 965/1, 2 and 3.

6 Tolerance grades

For each of the two main elements, pitch diameter and crest diameter, a number of tolerance grades have been established. In each case, grade 6 shall be used for tolerance quality Medium and Normal length of thread engagement. The grades below 6 are intended for tolerance quality Fine and/or Short lengths of thread engagement. The grades above 6 are intended for tolerance quality Coarse and/or Long lengths of thread engagement. In some grades, certain tolerance values for small pitches are not shown because of insufficient thread overlap or the requirement that the pitch diameter tolerance shall not exceed the crest diameter tolerance.

7 Tolerance positions

The following tolerance positions are standardized :

— for nuts : G with positive fundamental deviation
H with zero fundamental deviation

— for bolts : e, f and g with negative fundamental deviation
h with zero fundamental deviation

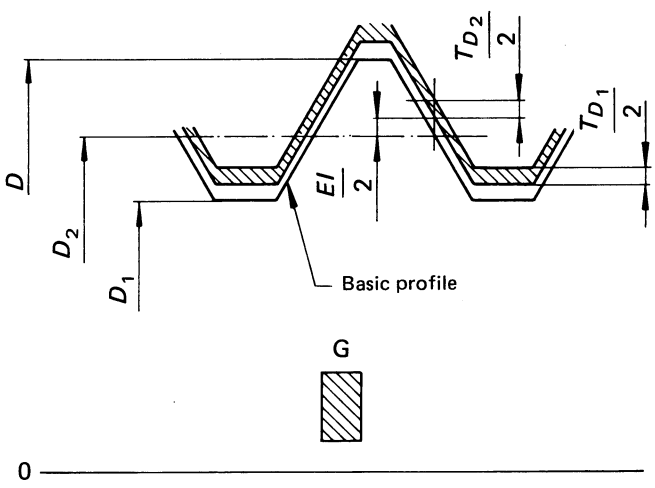


Figure 2 — Nut threads with tolerance position G

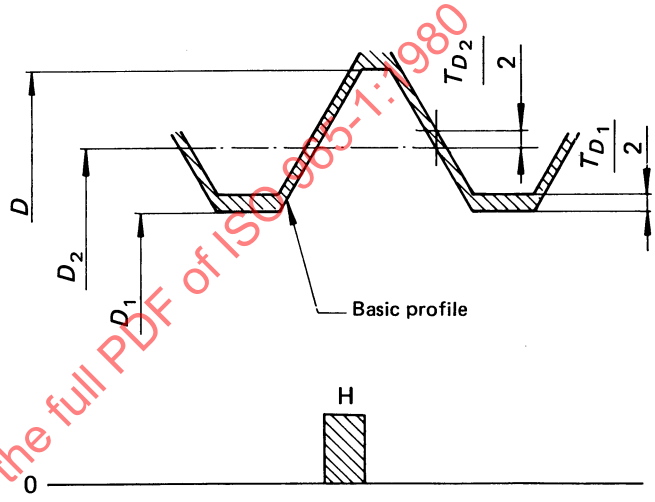


Figure 3 — Nut threads with tolerance position H

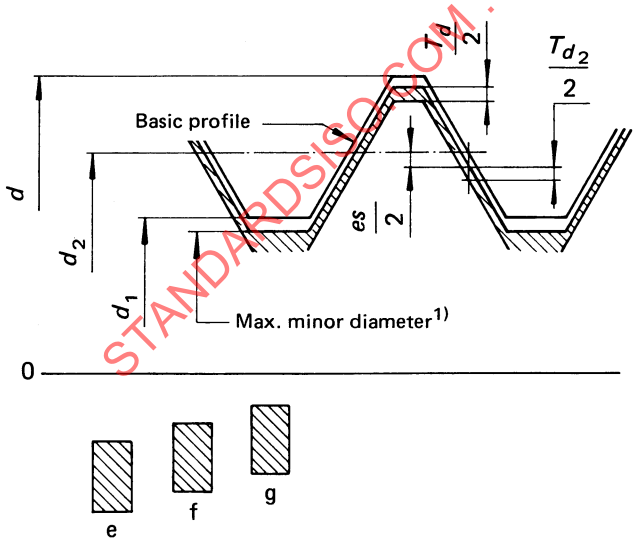


Figure 4 — Bolt threads with tolerance positions e, f and g

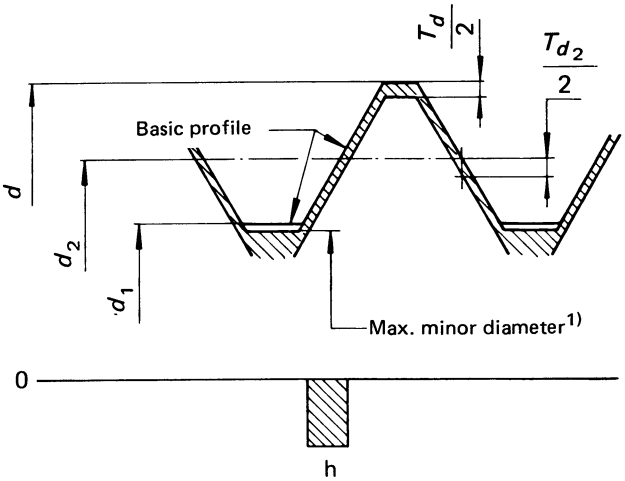


Figure 5 — Bolt threads with tolerance position h

1) Applicable only in connection with minimum material flanks (d_{2min}), see clause 11, figure 6.

Table 1 — Fundamental deviations for nut threads and bolt threads

Pitch *P*	Fundamental deviation					
	Nut thread D_2, D_1		Bolt thread d, d_2			
	G *EI*	H *EI*	e *es*	f *es*	g *es*	h *es*
mm	µm	µm	µm	µm	µm	µm
0,2	+ 17	0			− 17	0
0,25	+ 18	0			− 18	0
0,3	+ 18	0			− 18	0
0,35	+ 19	0		− 34	− 19	0
0,4	+ 19	0		− 34	− 19	0
0,45	+ 20	0		− 35	− 20	0
0,5	+ 20	0	− 50	− 36	− 20	0
0,6	+ 21	0	− 53	− 36	− 21	0
0,7	+ 22	0	− 56	− 38	− 22	0
0,75	+ 22	0	− 56	− 38	− 22	0
0,8	+ 24	0	− 60	− 38	− 24	0
1	+ 26	0	− 60	− 40	− 26	0
1,25	+ 28	0	− 63	− 42	− 28	0
1,5	+ 32	0	− 67	− 45	− 32	0
1,75	+ 34	0	− 71	− 48	− 34	0
2	+ 38	0	− 71	− 52	− 38	0
2,5	+ 42	0	− 80	− 58	− 42	0
3	+ 48	0	− 85	− 63	− 48	0
3,5	+ 53	0	− 90	− 70	− 53	0
4	+ 60	0	− 95	− 75	− 60	0
4,5	+ 63	0	− 100	− 80	− 63	0
5	+ 71	0	− 106	− 85	− 71	0
5,5	+ 75	0	− 112	− 90	− 75	0
6	+ 80	0	− 118	− 95	− 80	0

8 Lengths of thread engagement

The length of thread engagement is classified into one of three groups, S, N or L, in accordance with table 2.

Table 2 — Lengths of thread engagement

Dimensions in millimetres

Basic major diameter *d*		Pitch *P*	Length of thread engagement			
			S	N		L
over	up to and incl.		up to and incl.	over	up to and incl.	over
0,99	1,4	0,2	0,5	0,5	1,4	1,4
		0,25	0,6	0,6	1,7	1,7
		0,3	0,7	0,7	2	2
1,4	2,8	0,2	0,5	0,5	1,5	1,5
		0,25	0,6	0,6	1,9	1,9
		0,35	0,8	0,8	2,6	2,6
		0,4	1	1	3	3
		0,45	1,3	1,3	3,8	3,8
2,8	5,6	0,35	1	1	3	3
		0,5	1,5	1,5	4,5	4,5
		0,6	1,7	1,7	5	5
		0,7	2	2	6	6
		0,75	2,2	2,2	6,7	6,7
		0,8	2,5	2,5	7,5	7,5
5,6	11,2	0,75	2,4	2,4	7,1	7,1
		1	3	3	9	9
		1,25	4	4	12	12
		1,5	5	5	15	15
11,2	22,4	1	3,8	3,8	11	11
		1,25	4,5	4,5	13	13
		1,5	5,6	5,6	16	16
		1,75	6	6	18	18
		2	8	8	24	24
		2,5	10	10	30	30
22,4	45	1	4	4	12	12
		1,5	6,3	6,3	19	19
		2	8,5	8,5	25	25
		3	12	12	36	36
		3,5	15	15	45	45
		4	18	18	53	53
		4,5	21	21	63	63
45	90	1,5	7,5	7,5	22	22
		2	9,5	9,5	28	28
		3	15	15	45	45
		4	19	19	56	56
		5	24	24	71	71
		5,5	28	28	85	85
		6	32	32	95	95
90	180	2	12	12	36	36
		3	18	18	53	53
		4	24	24	71	71
		6	36	36	106	106
180	355	3	20	20	60	60
		4	26	26	80	80
		6	40	40	118	118

9 Crest diameter tolerances

9.1 Minor diameter tolerance of nut threads (T_{D_1})

For the minor diameter tolerance of nut thread T_{D_1}, there are five tolerance grades 4, 5, 6, 7 and 8, in accordance with table 3.

9.2 Major diameter tolerance of bolt thread (T_d)

For the major diameter tolerance of bolt thread, T_d, there are three tolerance grades, 4, 6 and 8, in accordance with table 4.

The tolerance grades 5 and 7 do not exist for the major diameter of bolt threads.

Table 3 — Minor diameter tolerances of nut thread (T_{D_1})

Pitch P	Tolerance grade				
	4	5	6	7	8
mm	µm	µm	µm	µm	µm
0,2	38	--	–	–	–
0,25	45	56	–	–	–
0,3	53	67	85	–	–
0,35	63	80	100	–	–
0,4	71	90	112	–	–
0,45	80	100	125	–	–
0,5	90	112	140	180	–
0,6	100	125	160	200	–
0,7	112	140	180	224	–
0,75	118	150	190	236	–
0,8	125	160	200	250	315
1	150	190	236	300	375
1,25	170	212	265	335	425
1,5	190	236	300	375	475
1,75	212	265	335	425	530
2	236	300	375	475	600
2,5	280	355	450	560	710
3	315	400	500	630	800
3,5	355	450	560	710	900
4	375	475	600	750	950
4,5	425	530	670	850	1 060
5	450	560	710	900	1 120
5,5	475	600	750	950	1 180
6	500	630	800	1 000	1 250

Table 4 — Major diameter tolerance of bolt thread (T_d)

Pitch P	Tolerance grade		
	4	6	8
mm	µm	µm	µm
0,2	36	56	–
0,25	42	67	–
0,3	48	75	–
0,35	53	85	–
0,4	60	95	–
0,45	63	100	–
0,5	67	106	–
0,6	80	125	–
0,7	90	140	–
0,75	90	140	–
0,8	95	150	236
1	112	180	280
1,25	132	212	335
1,5	150	236	375
1,75	170	265	425
2	180	280	450
2,5	212	335	530
3	236	375	600
3,5	265	425	670
4	300	475	750
4,5	315	500	800
5	335	530	850
5,5	355	560	900
6	375	600	950

10 Pitch diameter tolerances

For the pitch diameter tolerance of nut thread, T_{D_2}, there are five tolerance grades, 4, 5, 6, 7 and 8, in accordance with table 5.

Table 5 — Pitch diameter tolerance of nut thread (T_{D_2})

Basic major diameter *d*		Pitch *P*	Tolerance grade				
over	up to and incl.		4	5	6	7	8
mm	mm	mm	µm	µm	µm	µm	µm
0,99	1,4	0,2	40	–	–	–	–
		0,25	45	56	–	–	–
		0,3	48	60	75	–	–
1,4	2,8	0,2	42	–	–	–	–
		0,25	48	60	–	–	–
		0,35	53	67	85	–	–
		0,4	56	71	90	–	–
		0,45	60	75	95	–	–
2,8	5,6	0,35	56	71	90	–	–
		0,5	63	80	100	125	–
		0,6	71	90	112	140	–
		0,7	75	95	118	150	–
		0,75	75	95	118	150	–
		0,8	80	100	125	160	200
5,6	11,2	0,75	85	106	132	170	–
		1	95	118	150	190	236
		1,25	100	125	160	200	250
		1,5	112	140	180	224	280
11,2	22,4	1	100	125	160	200	250
		1,25	112	140	180	224	280
		1,5	118	150	190	236	300
		1,75	125	160	200	250	315
		2	132	170	212	265	335
		2,5	140	180	224	280	355
22,4	45	1	106	132	170	212	–
		1,5	125	160	200	250	315
		2	140	180	224	280	355
		3	170	212	265	335	425
		3,5	180	224	280	355	450
		4	190	236	300	375	475
		4,5	200	250	315	400	500
45	90	1,5	132	170	212	265	335
		2	150	190	236	300	375
		3	180	224	280	355	450
		4	200	250	315	400	500
		5	212	265	335	425	530
		5,5	224	280	355	450	560
		6	236	300	375	475	600
90	180	2	160	200	250	315	400
		3	190	236	300	375	475
		4	212	265	335	425	530
		6	250	315	400	500	630
180	355	3	212	265	335	425	530
		4	236	300	375	475	600
		6	265	335	425	530	670

For the pitch diameter tolerance of bolt thread, T_{D_2}, there are seven tolerance grades, 3, 4, 5, 6, 7, 8 and 9, in accordance with table 6.

Table 6 — Pitch diameter tolerance of bolt thread (T_{d_2})

Basic major diameter *d*		Pitch *P*	Tolerance grade						
over	up to and incl.		3	4	5	6	7	8	9
mm	mm	mm	µm	µm	µm	µm	µm	µm	µm
0,99	1,4	0,2	24	30	38	48	–	–	–
		0,25	26	34	42	53	–	–	–
		0,3	28	36	45	56	–	–	–
1,4	2,8	0,2	25	32	40	50	–	–	–
		0,25	28	36	45	56	–	–	–
		0,35	32	40	50	63	80	–	–
		0,4	34	42	53	67	85	–	–
		0,45	36	45	56	71	90	–	–
2,8	5,6	0,35	34	42	53	67	85	–	–
		0,5	38	48	60	75	95	–	–
		0,6	42	53	67	85	106	–	–
		0,7	45	56	71	90	112	–	–
		0,75	45	56	71	90	112	–	–
		0,8	48	60	75	95	118	150	190
5,6	11,2	0,75	50	63	80	100	125	–	–
		1	56	71	90	112	140	180	224
		1,25	60	75	95	118	150	190	236
		1,5	67	85	106	132	170	212	265
11,2	22,4	1	60	75	95	118	150	190	236
		1,25	67	85	106	132	170	212	265
		1,5	71	90	112	140	180	224	280
		1,75	75	95	118	150	190	236	300
		2	80	100	125	160	200	250	315
		2,5	85	106	132	170	212	265	335
22,4	45	1	63	80	100	125	160	200	250
		1,5	75	95	118	150	190	236	300
		2	85	106	132	170	212	265	335
		3	100	125	160	200	250	315	400
		3,5	106	132	170	212	265	335	425
		4	112	140	180	224	280	355	450
		4,5	118	150	190	236	300	375	475
45	90	1,5	80	100	125	160	200	250	315
		2	90	112	140	180	224	280	355
		3	106	132	170	212	265	335	425
		4	118	150	190	236	300	375	475
		5	125	160	200	250	315	400	500
		5,5	132	170	212	265	335	425	530
		6	140	180	224	280	355	450	560
90	180	2	95	118	150	190	236	300	375
		3	112	140	180	224	280	355	450
		4	125	160	200	250	315	400	500
		6	150	190	236	300	375	475	600
180	355	3	125	160	200	250	315	400	500
		4	140	180	224	280	355	450	560
		6	160	200	250	315	400	500	630

11 Root contours

For nut threads as well as bolt threads, the actual root contours shall not in any point transgress the basic profile.

For bolt threads on fasteners with strength grades 8.8 and higher (see ISO 898/1), the root profile shall have a non-reversing curvature, no portion of which shall have a radius of less than $0{,}125 \times P$ (see table 7).

In the maximum minor diameter position, the two radii of $R_{min} = 0{,}125 \times P$ will go through the points of intersection between the maximum material flanks and the minor diameter cylinder of the Go-gauges according to ISO 1502 and blend tangentially into the minimum material flanks.

The maximum truncation is equal to

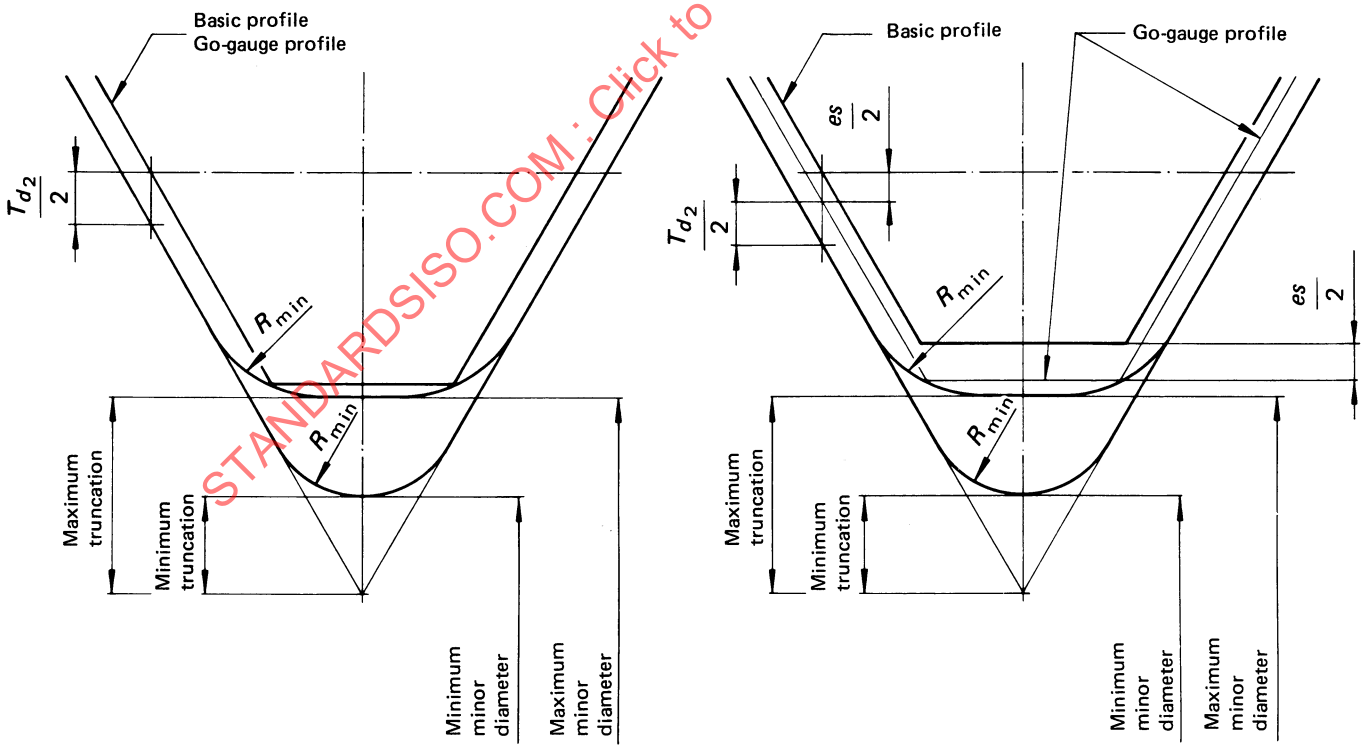
$$\frac{H}{4} - R_{min}\left[1 - \cos\left[\frac{\pi}{3} - \arccos\left(1 - \frac{T_{d_2}}{4 \times R_{min}}\right)\right]\right] + \frac{T_{d_2}}{2}$$

and the minimum truncation is equal to

$$0{,}125 \times P \approx \frac{H}{7}$$

Furthermore, it is recommended to take a truncation of $H/6$ ($R = 0{,}144\,34 \times P$) as the basis for stress calculations of the minor diameter of the bolt (for the corresponding values see ISO 965/3).

Bolt threads on fasteners with strength grades below 8.8 should preferably conform to the requirements stated above. This is particularly important for fasteners or other screwed connections which are subjected to fatigue or impact. However, there are in principle no restrictions other than that the maximum minor diameter of the thread shall be less than the minimum minor diameter of the Go-gauges according to ISO 1502.



a) Position h

b) Positions e, f and g

Figure 6 — Bolt root profile