

INTERNATIONAL
STANDARD

ISO
2903

Second edition
1993-11-01

**ISO metric trapezoidal screw threads —
Tolerances**

Filetages métriques trapézoïdaux ISO — Tolérances



Reference number
ISO 2903:1993(E)

Contents

	Page
1 Scope	1
2 Normative references	1
3 Definitions	1
4 Symbols	1
5 Structure of the tolerance system	1
6 Tolerance grades	2
7 Tolerance positions	2
8 Lengths of thread engagement	3
9 Crest and root diameter tolerances	3
10 Pitch diameter tolerances	3
11 Recommended tolerance classes	9
12 Multiple-start threads	9
13 Formulae	9
14 Designation	10

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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.

International Standard ISO 2903 was prepared by Technical Committee ISO/TC 1, *Screw threads*, Sub-Committee SC 2, *Tolerances*.

This second edition cancels and replaces the first edition (ISO 2903:1977), tables 1 and 7 of which have been technically revised.

ISO metric trapezoidal screw threads — Tolerances

1 Scope

This International Standard specifies a tolerance system for metric trapezoidal screw threads in accordance with ISO 2902. The tolerances refer to the basic profile ISO 2901.

The tolerance system does not apply to trapezoidal screw threads with special requirements on axial displacement, for example lead screws.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 965-1:1980, *ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data*.

ISO 2901:1993, *ISO metric trapezoidal screw threads — Basic profile and maximum material profiles*.

ISO 2902:1977, *ISO metric trapezoidal screw threads — General plan*.

ISO 5408:1983, *Cylindrical screw threads — Vocabulary*.

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 5408 apply.

4 Symbols

(See figures 1 to 4)

D_4	basic major diameter of nut thread, in millimetres
D_1	basic minor diameter of nut thread, in millimetres
D_2	basic pitch diameter of nut thread, in millimetres
d	basic major diameter of bolt thread, in millimetres
d_3	basic minor diameter of bolt thread, in millimetres
d_2	basic pitch diameter of bolt thread, in millimetres
P	pitch, in millimetres
P_h	lead, in millimetres
N	designation for thread engagement group "Normal"
L	designation for thread engagement group "Long"
l_N	thread engagement, in millimetres
T	tolerance, in micrometres
T_{D1}	} tolerances for D_1, D_2, d, d_3, d_2 (for D_4 no tolerances are specified), in micrometres
T_{D2}	
T_d	
T_{d3}	
T_{d2}	
ei, EI	lower deviations (EI for nut threads is equal to zero), in micrometres
es, ES	upper deviations, in micrometres

5 Structure of the tolerance system

The system is based on the tolerance system for ISO general-purpose metric screw threads of ISO 965-1, completed with tolerance positions c and e, and with values for pitches above 6 mm.

The recommended tolerance classes are, however, not the same as those for ISO metric screw threads in ISO 965-1.

6 Tolerance grades

The following tolerance grades are established:

	Tolerance grades		
Minor diameter of nut threads D_1 :	4		
Major diameter of bolt threads d :	4		
Pitch diameter of nut threads D_2 :	7	8	9
Pitch diameter of bolt threads d_2 :	(6)	7	8
Minor diameter of bolt threads d_3 :	7	8	9

Tolerance grade 6 for the pitch diameter (d_2) of the bolt thread has been included only as a means to establish the pitch diameter tolerances of grades 7, 8 and 9. See 13.4.2.

The tolerance grade for the minor diameter (d_3) of the bolt thread is always the same as for the pitch diameter (d_2).

However, the values for T_{d_3} and T_{d_2} are not the same for a same grade because $T_{d_3} = 1,25T_{d_2} + |es|$.

7 Tolerance positions

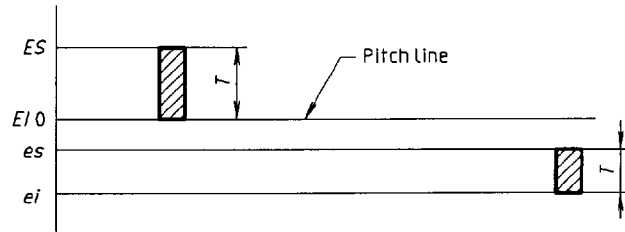


Figure 1 — Tolerance positions with respect to zero line (basic size)

The following tolerance positions are standardized for the pitch diameter.

- a) For nut threads: H with zero fundamental deviation (see figure 2 and table 1).
- b) For both threads: c and e with negative fundamental deviation (see figure 3 and table 1).

The tolerance position for the minor diameter D_1 and the major diameter D_4 of the nut threads is always H, i.e. with zero fundamental deviation. The tolerance position for the major diameter d and minor diameter d_3 of the bolt threads is in all cases h, i.e. with zero fundamental deviation, and it is independent of the tolerance position of the pitch diameter.

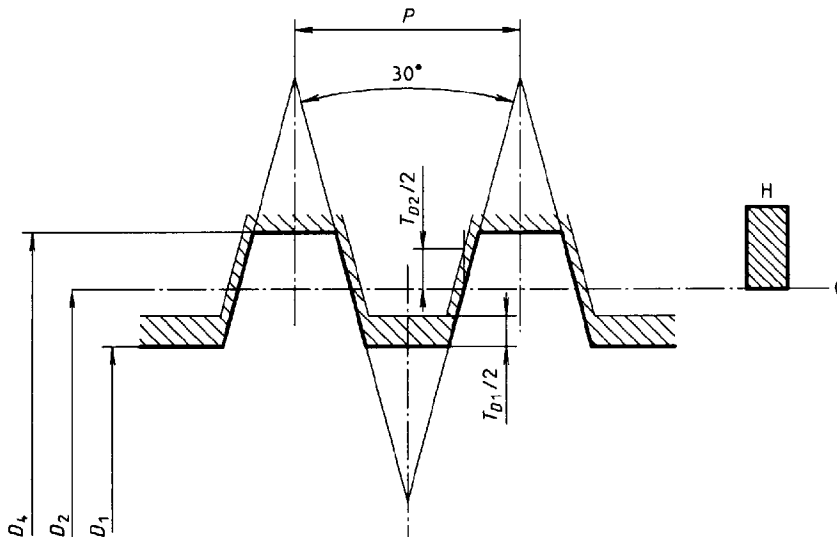


Figure 2 — Nut threads with tolerance position H for the pitch diameter

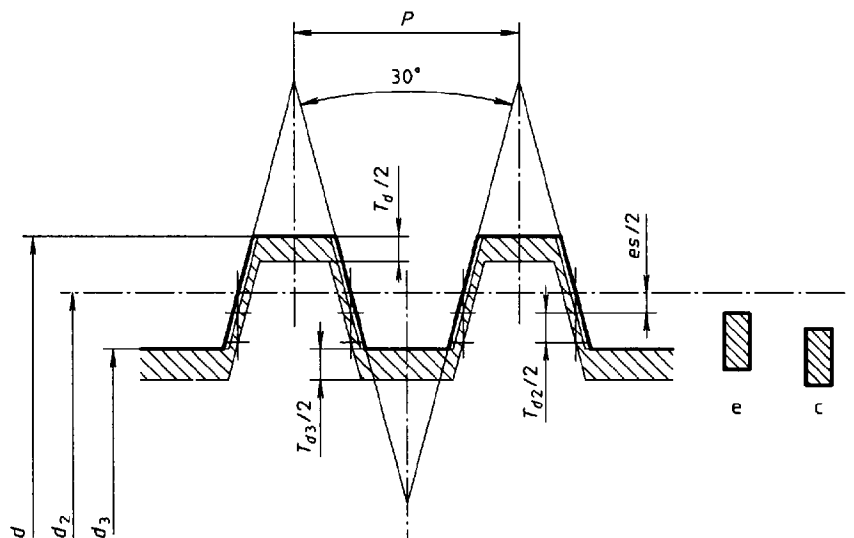


Figure 3 — Bolt threads with tolerance positions c and e for the pitch diameter

Table 1 — Fundamental deviations for the pitch diameter of nut threads and bolt threads

Pitch <i>P</i>	Fundamental deviation		
	Nut thread	Bolt thread	
	<i>D</i> ₂	<i>d</i> ₂	
	H <i>EI</i>	c <i>es</i>	e <i>es</i>
mm	μm	μm	μm
1,5	0	-140	-67
2	0	-150	-71
3	0	-170	-85
4	0	-190	-95
5	0	-212	-106
6	0	-236	-118
7	0	-250	-125
8	0	-265	-132
9	0	-280	-140
10	0	-300	-150
12	0	-335	-160
14	0	-355	-180
16	0	-375	-190
18	0	-400	-200
20	0	-425	-212
22	0	-450	-224
24	0	-475	-236
28	0	-500	-250
32	0	-530	-265
36	0	-560	-280
40	0	-600	-300
44	0	-630	-315

8 Lengths of thread engagement

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

9 Crest and root diameter tolerances

9.1 Minor diameter tolerances of nut thread (*T_{D1}*)

For the minor diameter tolerance of the nut thread, *T_{D1}*, there is only one tolerance grade, 4 (see table 3).

9.2 Major diameter tolerances of bolt thread (*T_d*)

For the major diameter tolerance of the bolt thread, *T_d*, there is only one tolerance grade, 4 (see table 4).

9.3 Minor diameter tolerances of bolt thread (*T_{d3}*)

For the minor diameter tolerance of the bolt thread, *T_{d3}*, there are three tolerance grades, 7, 8, and 9, in accordance with table 5.

10 Pitch diameter tolerances

For the pitch diameter tolerances there are three tolerance grades, 7, 8 and 9 for nut threads, in accordance with table 6, and four tolerance grades, 6, 7, 8 and 9 for bolt threads, in accordance with table 7.

Table 2 — Lengths of thread engagement

Dimensions in millimetres

Basic major diameter <i>d</i>		Pitch <i>P</i>	Groups of lengths of thread engagement, <i>l</i>		
			N		L
			over	up to and incl.	over
5,6	11,2	1,5	5	15	15
		2	6	19	19
		3	10	28	28
11,2	22,4	2	8	24	24
		3	11	32	32
		4	15	43	43
		5	18	53	53
		8	30	85	85
22,4	45	3	12	36	36
		5	21	63	63
		6	25	75	75
		7	30	85	85
		8	34	100	100
		10	42	125	125
		12	50	150	150
45	90	3	15	45	45
		4	19	56	56
		8	38	118	118
		9	43	132	132
		10	50	140	140
		12	60	170	170
		14	67	200	200
		16	75	236	236
		18	85	265	265
90	180	4	24	71	71
		6	36	106	106
		8	45	132	132
		12	67	200	200
		14	75	236	236
		16	90	265	265
		18	100	300	300
		20	112	335	335
		22	118	355	355
		24	132	400	400
		28	150	450	450
180	355	8	50	150	150
		12	75	224	224
		18	112	335	335
		20	125	375	375
		22	140	425	425
		24	150	450	450
		32	200	600	600
		36	224	670	670
		40	250	750	750
		44	280	850	850

Table 3 — Minor diameter tolerances of nut threads (T_{D1})

Pitch <i>P</i>	Tolerance grade 4
mm	µm
1,5	190
2	236
3	315
4	375
5	450
6	500
7	560
8	630
9	670
10	710
12	800
14	900
16	1 000
18	1 120
20	1 180
22	1 250
24	1 320
28	1 500
32	1 600
36	1 800
40	1 900
44	2 000

Table 4 — Major diameter tolerances of bolt threads (T_d)

Pitch <i>P</i>	Tolerance grade 4
mm	µm
1,5	150
2	180
3	236
4	300
5	335
6	375
7	425
8	450
9	500
10	530
12	600
14	670
16	710
18	800
20	850
22	900
24	950
28	1 060
32	1 120
36	1 250
40	1 320
44	1 400

Table 5 — Minor diameter tolerances of bolt thread (T_{d3})

Basic major diameter <i>d</i>		Pitch <i>P</i>	Tolerance position <i>c</i> of the pitch diameter tolerance			Tolerance position <i>e</i> of the pitch diameter tolerance			
over	up to		Tolerance grades			Tolerance grades			
mm	mm		7	8	9	7	8	9	
mm	mm	mm	µm	µm	µm	µm	µm	µm	
5,6	11,2	1,5	352	405	471	279	332	398	
		2	388	445	525	309	366	446	
		3	435	501	589	350	416	504	
11,2	22,4	2	400	462	544	321	383	465	
		3	450	520	614	365	435	529	
		4	521	609	690	426	514	595	
		5	562	656	775	456	550	669	
		8	709	828	965	576	695	832	
22,4	45	3	482	564	670	397	479	585	
		5	587	681	806	481	575	700	
		6	655	767	899	537	649	781	
		7	694	813	950	569	688	825	
		8	734	859	1 015	601	726	882	
		10	800	925	1 087	650	775	937	
		12	866	998	1 223	691	823	1 048	

Basic major diameter <i>d</i>		Pitch <i>P</i>	Tolerance position <i>c</i> of the pitch diameter tolerance			Tolerance position <i>e</i> of the pitch diameter tolerance				
over	up to		Tolerance grades			Tolerance grades				
mm	mm		7	8	9	7	8	9		
mm	mm	mm	μm	μm	μm	μm	μm	μm		
45	90	3	501	589	701	416	504	616		
		4	565	659	784	470	564	689		
		8	765	890	1 052	632	757	919		
		9	811	943	1 118	671	803	978		
		10	831	963	1 138	681	813	988		
		12	929	1 085	1 273	754	910	1 098		
		14	970	1 142	1 355	805	967	1 180		
		16	1 038	1 213	1 438	853	1 028	1 253		
		18	1 100	1 288	1 525	900	1 088	1 320		
		90	180	4	584	690	815	489	595	720
				6	705	830	986	587	712	868
				8	796	928	1 103	663	795	970
12	960			1 122	1 335	785	947	1 160		
14	1 018			1 193	1 418	843	1 018	1 243		
16	1 075			1 263	1 500	890	1 078	1 315		
18	1 150			1 338	1 588	950	1 138	1 388		
20	1 175			1 363	1 613	962	1 150	1 400		
22	1 232			1 450	1 700	1 011	1 224	1 474		
24	1 313			1 538	1 800	1 074	1 299	1 561		
28	1 388			1 625	1 900	1 138	1 375	1 650		
180	355			8	828	965	1 153	695	832	1 020
		12	998	1 173	1 398	823	998	1 223		
		18	1 187	1 400	1 650	987	1 200	1 450		
		20	1 263	1 488	1 750	1 050	1 275	1 537		
		22	1 288	1 513	1 775	1 062	1 287	1 549		
		24	1 363	1 600	1 875	1 124	1 361	1 636		
		32	1 530	1 780	2 092	1 265	1 515	1 827		
		36	1 623	1 885	2 210	1 343	1 605	1 930		
		40	1 663	1 925	2 250	1 363	1 625	1 950		
		44	1 755	2 030	2 380	1 440	1 715	2 065		

Table 6 — Pitch diameter tolerances of nut thread (T_{D2})

Basic major diameter		Pitch P	Tolerance grades		
over d mm	up to and incl. mm		7 μm	8 μm	9 μm
5,6	11,2	1,5 2 3	224 250 280	280 315 355	355 400 450
11,2	22,4	2 3 4	265 300 355	335 375 450	425 475 560
		5 8	375 475	475 600	600 750
22,4	45	3 5 6	335 400 450	425 500 560	530 630 710
		7 8 10 12	475 500 530 560	600 630 670 710	750 800 850 900
		3 4 8	355 400 530	450 500 670	560 630 850
		9 10 12	560 560 630	710 710 800	900 900 1 000
45	90	14 16 18	670 710 750	850 900 950	1 060 1 120 1 180
		4 6 8 12	425 500 560 670	530 630 710 850	670 800 900 1 060
		14 16 18	710 750 800	900 950 1 000	1 120 1 180 1 250
90	180	20 22 24 28	800 850 900 950	1 000 1 060 1 120 1 180	1 250 1 320 1 400 1 500
		8 12 18	600 710 850	750 900 1 060	950 1 120 1 320
		20 22 24	900 900 950	1 120 1 120 1 180	1 400 1 400 1 500
		32 36 40 44	1 060 1 120 1 120 1 250	1 320 1 400 1 400 1 500	1 700 1 800 1 800 1 900
		8 12 18	600 710 850	750 900 1 060	950 1 120 1 320

Table 7 — Pitch diameter tolerances of bolt thread (T_{d2})

Basic major diameter		Pitch <i>P</i>	Tolerance grades				
over <i>d</i>	up to and incl.		6	7	8	9	
mm	mm	mm	µm	µm	µm	µm	
5,6	11,2	1,5	132	170	212	265	
		2	150	190	236	300	
		3	170	212	265	335	
11,2	22,4	2	160	200	250	315	
		3	180	224	280	355	
		4	212	265	335	425	
		5	224	280	355	450	
		8	280	355	450	560	
22,4	45	3	200	250	315	400	
		5	236	300	375	475	
		6	265	335	425	530	
		7	280	355	450	560	
		8	300	375	475	600	
		10	315	400	500	630	
		12	335	425	530	670	
45	90	3	212	265	335	425	
		4	236	300	375	475	
		8	315	400	500	630	
		9	335	425	530	670	
		10	335	425	530	670	
		12	375	475	600	750	
		14	400	500	630	800	
		16	425	530	670	850	
		18	450	560	710	900	
90	180	4	250	315	400	500	
		6	300	375	475	600	
		8	335	425	530	670	
		12	400	500	630	800	
		14	425	530	670	850	
		16	450	560	710	900	
		18	475	600	750	950	
		20	475	600	750	950	
		22	500	630	800	1 000	
		24	530	670	850	1 060	
		28	560	710	900	1 120	
180	355	8	355	450	560	710	
		12	425	530	670	850	
		18	500	630	800	1 000	
		20	530	670	850	1 060	
		22	530	670	850	1 060	
		24	560	710	900	1 120	
		32	630	800	1 000	1 250	
		36	670	850	1 060	1 320	
		40	670	850	1 060	1 320	
		44	710	900	1 120	1 400	

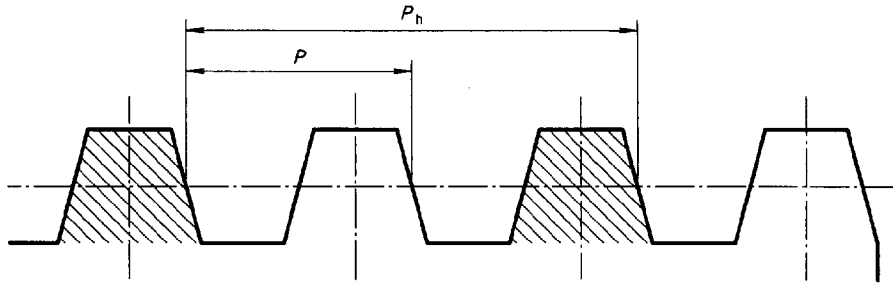


Figure 4 — Lead and pitch of multiple-start thread

11 Recommended tolerance classes

In order to reduce the number of gauges and tools, the tolerances should preferably be chosen from tables 8 and 9.

The following general rules can be formulated for the choice of tolerance quality.

- a) Medium: for general use.
- b) Coarse: for cases when manufacturing difficulties can arise.

If the actual length of thread engagement is unknown, group N is recommended.

Table 8 — Recommended tolerance classes for nut threads

Tolerance quality	Tolerances for the pitch diameter	
	N	L
Medium	7H	8H
Coarse	8H	9H

Table 9 — Recommended tolerance classes for bolt threads

Tolerance quality	Tolerances for the pitch diameter	
	N	L
Medium	7e	8e
Coarse	8c	9c

12 Multiple-start threads

The tolerances for multiple-start threads (see figure 4) are the same as for single-start threads, with the exception of the pitch diameter tolerances which are enlarged.

The tolerance values for T_{D2} and T_{d2} , specified in tables 6 and 7, shall, for multiple-start threads, be multiplied by a factor according to table 10.

Table 10 — Factors for multiple-start threads

Number of starts	2	3	4	5 and larger
Factor	1,12	1,25	1,4	1,6

13 Formulae

13.1 Fundamental deviations

The fundamental deviations for nut and bolt threads have been calculated according to the following formulae.

for $EI_H = 0$

$$es_c = -(125 + 11P) \text{ for } P \text{ up to and including } 2$$

$$es_c = -5 + 94,12\sqrt{P} \text{ for } P = 3 \text{ to } P = 44$$

$$es_e = -(50 + 11P) \text{ for } P \text{ up to and including } 3$$

$$es_e = -47,49\sqrt{P} \text{ for } P = 4 \text{ to } P = 44$$

13.2 Length of thread engagement

For the calculation of the limits of the normal length of thread engagements l_N in table 2, the following rule has been applied.

For each pitch within a certain diameter range, d has been set equal to the smallest diameter (within the range) which appears in table 2.

$$l_N \text{ min.} = 2,24Pd^{0,2}$$

$$l_N \text{ max.} = 6,7Pd^{0,2}$$

13.3 Crest diameter tolerances

13.3.1 Tolerances for minor diameter of nut thread (T_{D1})

The T_{D1} tolerances for grade 4 are calculated according to the following formula:

$$T_{D1} = 0,63 (230P^{0,7})$$

13.3.2 Tolerances for major diameter of bolt thread (T_d)

The T_d tolerances for grade 4 are calculated according to the following formula:

$$T_d = 0,63 \left(180 \sqrt[3]{P^2} - \frac{3,15}{\sqrt{P}} \right)$$

13.3.3 Tolerances for minor diameter of bolt thread (T_{d3})

The T_{d3} tolerances are obtained from the T_{d2} values according to the following formula:

$$T_{d3} = 1,25T_{d2} + |es|$$

13.4 Pitch diameter tolerances

13.4.1 Tolerances for pitch diameter of nut thread (T_{D2})

The T_{D2} tolerances are obtained from the tolerances for grade 6, T_{d2} (6), (see table 7) according to table 11.

Table 11 — Tolerances for pitch diameter of nut thread (T_{D2})

Tolerance grades		
7	8	9
$1,7T_{d2}$ (6)	$2,12T_{d2}$ (6)	$2,65T_{d2}$ (6)

13.4.2 Tolerances for pitch diameter of bolt thread (T_{d2})

The T_{d2} tolerances are calculated according to the following formulae (d equal to the geometrical mean value of the diameter range limits):

$$T_{d2} (6) = 90P^{0,4} \times d^{0,1}$$

$$T_{d2} (7) = 1,25T_{d2} (6)$$

$$T_{d2} (8) = 1,6T_{d2} (6)$$

$$T_{d2} (9) = 2T_{d2} (6)$$

13.5 Rules of rounding

The values for pitch and crest diameter tolerances and for fundamental deviations have been calculated for the formulae above and then rounded off to the nearest value in the R40 series of preferred numbers.

The calculated values for the minor diameter tolerances T_{d3} have not been rounded.

14 Designation

A complete designation for a screw thread shall comprise a designation for the thread system and size, and a designation for the thread tolerance.

The thread designation shall be as given in ISO 2902.

The tolerance designation consists of a symbol for the pitch diameter tolerance only.

There is no need to designate the crest diameter tolerance since

- the tolerance position is always the same;
- only one tolerance grade is established for the minor diameter of nut threads (D_1) and for the major diameter of bolt threads (d).

Each tolerance designation shall comprise:

- a figure indicating the grade of the pitch diameter tolerance;
- a letter indicating the position of the pitch diameter tolerance, capital for nuts, small for bolts.

EXAMPLES

For nut threads:

$$\text{Tr } 40 \times 7 - 7\text{H}$$

For bolt threads:

$$\text{Tr } 40 \times 7 - 7\text{e}$$

For two-start, left-hand bolt threads:

$$\text{Tr } 40 \times 14 (\text{P7}) \text{ LH} - 7\text{e}$$

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

EXAMPLES

$$\text{Tr } 40 \times 7 - 7\text{H}/7\text{e}$$

$$\text{Tr } 40 \times 14 (\text{P7}) - 7\text{H}/7\text{e}$$

ISO 2903:1993(E)

UDC 621.882.082.4:621.753.1

Descriptors: screw threads, ISO metric threads, ACME threads, classification, dimensional tolerances, rounding (numbers), designation.

Price based on 10 pages
