AMERICAN NATIONAL STANDARD

Buttress Inch Screw Threads

7°/45° Form With 0.6 Pitch Basic Height of Thread Engagement

ANSI B1.9 - 1973

REAFFIRMED 1985

REAFFIRMED 1992

FOR CURRENT COMMITTEE PERSONNEL
PLEASE SEE ASME MANUAL AS-11

SECRETARIAT

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

PUBLISHED BY

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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AREA THDS

Incorporates 2/79 Errata

FOREWORD

Although the buttress thread was described as early as the March, 1888, Journal of the Franklin Institute, it was so little used that its national standardization was not undertaken until after the Combined Conservation Committee in early 1942 reviewed the standardization status of items needed in the war effort. Formerly each application of the buttress thread was treated individually and the form it took depended on the experience of the designer and the manufacturing equipment available.

At the American-British-Canadian conference in New York, in 1943, they agreed that a basic profile should be established for this thread. As the Military Departments needed buttress and other special types of threads, the War Production Board in February, 1944, arranged with the ASA to establish a General War Committee on Screw Threads.

The Interdepartmental Screw Thread Committee (ISTC) agreed to develop a buttress thread form having a pressure flank angle of 7 deg, which closely approaches the static angle of friction for well lubricated steel surfaces in contact, and a clearance flank angle of 45 deg.

The British agreed to prepare and circulate a draft specification for an asymmetrical buttress thread having a 7 deg load flank angle, a 45 deg clearance flank angle, and a basic height of thread engagement of 0.4 pitch.

The 1944 edition of Handbook H28 published the ISTC's recommendation of a basic buttress thread form which had a crest flat in the nut twice that of the screw, and a thread engagement height of approximately 0.56*p*. In November 1944, the ASA War Subcommittee on Buttress Threads was established and after reviewing the British draft of April 1945, this committee felt that because of the distortion tendency of thin wall tubing, a greater basic height of thread engagement than 0.4*p* was desirable, especially since the minimum height of thread engagement is necessarily less than 0.4*p* by one-half the sum of the allowance and the tolerances on minor diameter of internal thread and major diameter of external thread. Therefore, the July 1945 draft of the War Standard was based on a basic height of thread engagement of 0.5*p*.

Another American-British-Canadian conference sponsored by the Combined Production and Resources Board was held in Ottawa, Canada, September-October 1945. Here the British proposal of April 1945, with an alternate design of 0 deg pressure flank angle and a trailing flank angle of 52 deg, was reviewed and compared with the American proposal of July 1945. Learning that the British had had considerable favorable experience on thin wall tubing with buttress threads having 0.4*p* basic height of thread engagement, it was decided that the American standard might adopt this basis. Accord was also reached on preferred diameters and pitches, thread dimension tolerances and allowances, and on having each standard include in its appendix an alternate thread of 0 degree pressure flank angle. Further, each country agreed to publish the standard in conformance with their respective formats.

In April 1946, buttress threads were assigned to Subcommittee No. 3 of the Sectional Committee on the Standardization and Unification of Screw Threads, B1, and the committee membership was enlarged. This committee prepared and circulated in 1948 to members of the B1 committee a draft of a proposed standard based on the British proposal with a basic thread height of 0.4*p*. The comments included so many objections to the shallow height of thread that in 1949 the committee decided to base the next draft on a thread having 0.6*p* engagement height. The committee also voted not to include in the appendix of the American standard data for a buttress thread having 0 deg pressure flank angle as it was evident that this was only one of several modifications that might be needed for special applications.

The next American-British-Canadian conference was called at the request of the Director of Defense Mobilization and held in New York, June 1952. The British Standard 1657: 1950 for Buttress Threads which is based on a thread engagement height of 0.4*p* and the American draft of September 1951, based on thread engagement height of 0.6*p*, were reviewed. It was concluded that the applications for buttress threads are so varied that threads with either engagement height (0.4*p* or 0.6*p*) might be preferred for particular design requirements. It was recommended that the next printing of the British standard and the forthcoming American standard include the essential details of the other country's standards in appendixes. ASA B1.9-1953, Buttress Screw Threads, was issued in conformance with this recommendation.

This 1973 Revision of B1.9 is being issued to bring the standard into conformance with present practices. The three classes of threads have been reduced to two—Class 2 (standard grade) and Class 3 (precision grade).

Following approval by the Sectional Committee of B1, and the Secretariats, the revised standard was submitted to the American National Standards Institute for approval. This approval was granted on October 22, 1973.

AMERICAN NATIONAL STANDARDS COMMITTEE B1
Standardization and Unification of Screw Threads

(The following is the roster of the Committee at the time of approval of this standard)

Organized . . . . June, 1921
Reorganized . . . . February, 1929

SPONSORS: Society of Automotive Engineers
The American Society of Mechanical Engineers

SCOPE: Nomenclature of screw threads; form of threads; diameter and pitches of screws for various uses; classification of thread fits, tolerances and allowances for threaded parts; and the gaging of threads. Screw threads for fire hose couplings are not included within the scope.

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AMERICAN NATIONAL STANDARD

BUTTRESS INCH SCREW THREADS

GENERAL

The buttress form of thread has certain advantages in applications involving exceptionally high stresses along the thread axis in one direction only. As the thrust side (load flank) of the standard buttress thread is made very nearly perpendicular to the thread axis, the radial component of the thrust is reduced to a minimum. On account of the small radial thrust, the buttress form of thread is particularly applicable when tubular members are screwed together. Examples of actual applications are the breech assemblies of large guns, airplane propeller hubs, and columns for hydraulic presses.

In selecting the form of thread recommended as standard, manufacture by milling, grinding, rolling, or other suitable means, has been taken into consideration. All dimensions are in inches.

SPECIFICATIONS

1 SCOPE

This standard relates to screw threads of buttress form and provides:

(a) A form of 7°/45° buttress thread with 0.6*p* basic height of thread engagement (see Fig. 1a).

(b) A table of preferred diameter-pitch combinations (see Table 1).

(c) A formula for calculating pitch diameter tolerances (see Par. 6.1).

(d) Tolerances for major and minor diameters (see Par. 6.2 and 6.3).

(e) A system of allowances between external and internal threads (see Par. 7).

(f) Recommended methods of measuring and gaging (see Par. 10 and 11).

(g) Dimensional acceptability of buttress product (see Section 12).

[a]In instances where absence of root radius is not detrimental to the requirements for strength, and where it is more economical to provide tools which do not produce a radius at root, flat root buttress threads may be specified.

APPENDIXES

The following appendixes are included in this standard:

(1) Pitch Diameter Equivalents for Lead and Flank Angle Deviations

(2) Pitch Diameter Measurement for External and Internal Buttress Threads

(3) 7°/45° British Standard Buttress Thread with 0.4*p* Basic Height of Thread Engagement.

1.1 The intent of this standard is not to preclude the use of other measuring or gaging systems provided they are properly correlated.

2 DEFINITIONS

See ANSI B1.7.

3 FORM OF THREAD

The form of the buttress thread is shown in Figs. 1a and 1b and has the following characteristics:

(a) A load flank angle, measured in an axial plane, of 7 degrees from the normal to the axis

(b) A clearance flank angle, measured in an axial plane, of 45 degrees from the normal to the axis

(c) Equal truncations at the crests of the external and internal threads such that the basic height of thread engagement (assuming no allowance) is equal to 0.6 of the pitch

(d) *Roots of threads*

(1) Equal radii, at the roots of the external and internal basic thread forms tangential to the load flank and the clearance flank (see Section 4, note a). There is, in practice, almost no chance that the thread forms will be achieved strictly as basically specified, that is, as true radii.

(2) Equal flat root of the external and internal thread (see footnote a).

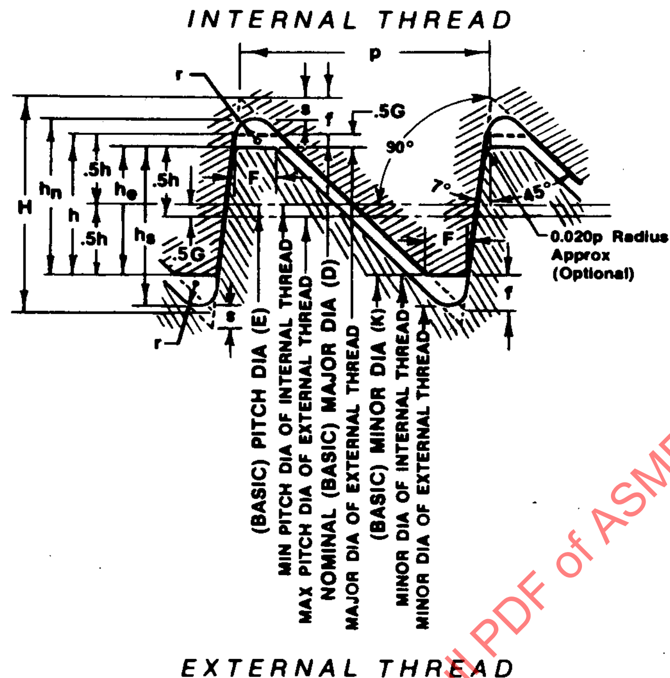


FIG. 1a FORM OF STANDARD 7°/45° BUTTRESS THREAD WITH 0.6p BASIC HEIGHT OF THREAD ENGAGEMENT AND ROUND ROOT

(Heavy line indicates basic form)

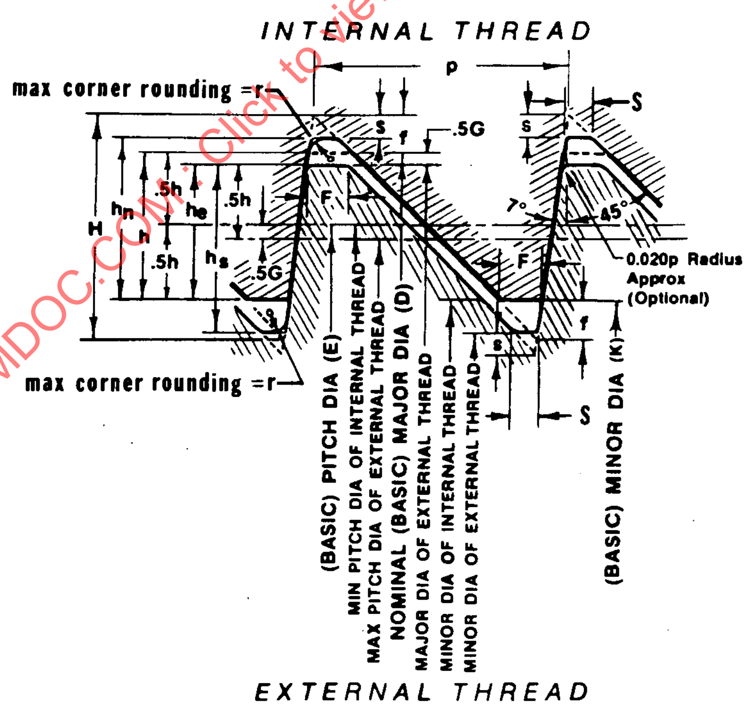


FIG. 1b FORM OF 7°/45° BUTTRESS THREAD WITH 0.6p BASIC HEIGHT OF THREAD ENGAGEMENT AND FLAT ROOT

(Heavy line indicates basic form)

4 SYMBOLS AND FORMULAS

	Max Material (Basic)	Min Material
Pitch	p	
Height of sharp-V thread	$H = 0.89064p$	
Basic height of thread engagement	$h = 0.6p$	
Root radius (theoretical) (see footnote a)	$r = 0.07141p$	Min r = $0.0357p$
Root truncation	$s = 0.0826p$	Min s = 0.5 Max $s = 0.0413p$
Root truncation for flat root form	$s = 0.0826p$	Min s = 0.5 Max $s = 0.0413p$
Flat width for flat root form	$S = 0.0928p$	Min S = $0.0464p$
Allowance	G (see par. 7)	
Height of thread engagement	$h_e = h - 0.5G$	Min h_e = Max h_e – [0.5 tol. on major diam external thread + 0.5 tol. on minor diam internal thread].
Crest truncation	$f = 0.14532p$	
Crest width	$F = 0.16316p$	
Major diameter	D	
Major diameter of internal thread	$D_n = D + 0.12542p$	Max D_n = Max pitch diam of internal thread + $0.80803p$
Major diameter of external thread	$D_s = D - G$	Min D_s = $D - G - D$ tol.
Pitch diameter	E	
Pitch diameter of internal thread (see footnote b)	$E_n = D - h$	Max E_n = $D - h + PD$ tol.
Pitch diameter of external thread (see footnote c)	$E_s = D - h - G$	Min E_s = $D - h - G - PD$ tol.
Minor diameter	K	
Minor diameter of external thread	$K_s = D - 1.32542p - G$	Min K_s = Min pitch diam of external thread – $0.80803p$
Minor diameter of internal thread	$K_n = D - 2h$	Min K_n = $D - 2h + K$ tol.
Height of thread of internal thread	$h_n = 0.66271p$	
Height of thread of external thread	$h_s = 0.66271p$	
Pitch diameter increment for lead	ΔE_l	
Pitch diameter increment for 45° clearance flank angle	ΔE_{α_1}	
Pitch diameter increment for 7° load flank angle	ΔE_{α_2}	
Length of engagement	L_e	

[a] Unless the flat root form is specified, the rounded root form of the external and internal thread shall be a continuous, smoothly-blended curve within the zone defined by $0.07141p$ maximum to $0.0357p$ minimum radius. The resulting curve shall have no reversals and sudden angular variations, and shall be tangent to the flanks of the thread. There is, in practice, almost no chance that the rounded thread form will be achieved strictly as basically specified, that is, as a true radius.

[b] The pitch diameter X tolerances for GO and NOT GO threaded plug gages are applied to the internal product limits for E_n and Max E_n.

[c] The pitch diameter W tolerances for GO and NOT GO threaded setting plug gages are applied to the external product limits for E_s and Min E_s.

5 PREFERRED DIAMETER-PITCH COMBINATIONS

A tabulation of diameter-pitch combinations is shown in Table 1. Threads per inch, between heavy lines, should be used if possible with preference given to the middle one. Basic dimensions for each of the pitches are given in Table 2.

6 TOLERANCES

Tolerances from basic size on external threads are applied in a minus direction and on internal threads in a plus direction (see Fig. 2).

6.1 Pitch Diameter Tolerances

The following formula is used for determining the pitch diameter product tolerance for external or internal threads:

Class 2 (standard grade) Pitch Diameter Tolerance:

$$\text{PD tolerance} = 0.002\sqrt[3]{D} + 0.00278\sqrt{L_e} + 0.00854\sqrt{p}$$

where

D = basic major diameter of external thread (assuming no allowance)

L_e = length of engagement

p = pitch of thread

When the length of engagement is taken as $10p$, the formula reduces to:

$$0.002\sqrt[3]{D} + 0.0173\sqrt{p}$$

It is to be noted that this formula relates specifically to Class 2 (standard grade) PD tolerances. Class 3 (precision grade) PD tolerances are two-thirds of Class 2 PD tolerances. Pitch diameter tolerances, based on

Table 1 Diameter-Pitch Combinations for 7°/45° Buttress Threads

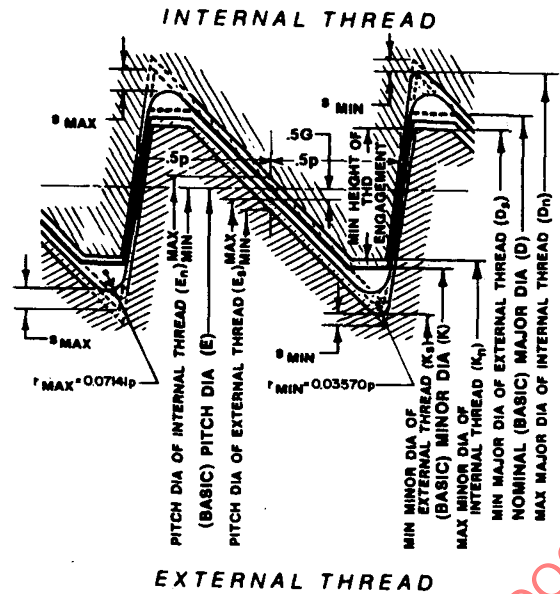
Major Diameter Range	Preferred Nominal Major Diameters	Threads per Inch Preferred TPI Between Heavy Lines													
From 0.5 thru 0.75	0.5, 0.625, 0.75	20[a]	16	12											
Over 0.75 thru 1.0	0.875, 1.0		16[a]	12	10										
Over 1.0 thru 1.5	1.25, 1.375 1.5		16	12[a]	10	8	6								
Over 1.5 thru 2.5	1.75, 2, 2.25, 2.5		16	12	10[a]	8	6	5	4						
Over 2.5 thru 4	2.75, 3, 3.5, 4		16	12	10	8	6	5	4						
Over 4 thru 6	4.5, 5, 5.5 6			12	10	8	6	5	4	3					
Over 6 thru 10	7, 8, 9, 10				10	8	6	5	4	3	2.5	2			
Over 10 thru 16	11, 12, 14, 16				10	8	6	5	4	3	2.5	2	1.5	1.25	
Over 16 thru 24	18, 20, 22, 24					8	6	5	4	3	2.5	2	1.5	1.25	1

[a]When the pitch diameter is measured with "best-size" wires the measurement may be incorrect due to the double contact of the wire on the 7° flank because the lead angle exceeds 2°.

Table 2 Basic Dimensions for 7°/45° Buttress Threads of Preferred Pitches

Threads[a] per Inch, n	Pitch, p	Basic Height of Thread, $h = 0.6p$	Height of Sharp V Thread, $H = 0.89064p$	Height of Thread, h_s or $h_n = 0.66271p$	$2h_s$ or $2h_n = 1.32542p$	$2h_s - 2h = 2h_n - 2h = 0.12542p$	Root[b] Radius		Root Truncation		Crest Truncation, $f = 0.14532p$	Width of Flat at Crest, $F = 0.16316p$	$2\left(\frac{H}{2} - s_{min}\right) =$[c] $0.80803p$	Component for pitch in PD tol. formula[d] $0.00854\sqrt{p}$	For[e] NOT-GO Gage Crests $0.35p$	Root Relief Width[f] for Thread Gages	
							Max $r = 0.0714p$	Min $r = 0.0357p$	Max $s = 0.0826p$	Min $s = 0.0413p$						GO $0.167p$	NOT GO $0.25p$
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
20	0.0500	0.0300	0.0445	0.0331	0.0663	0.0063	0.0036	0.0018	0.0041	0.0021	0.0073	0.0082	0.0404	0.0019	0.0175	0.0084	0.0125
16	0.0625	0.0375	0.0557	0.0414	0.0828	0.0078	0.0045	0.0022	0.0052	0.0026	0.0091	0.0102	0.0505	0.0021	0.0219	0.0104	0.0156
12	0.0833	0.0500	0.0742	0.0552	0.1104	0.0104	0.0059	0.0030	0.0069	0.0034	0.0121	0.0136	0.0673	0.0025	0.0292	0.0139	0.0208
10	0.1000	0.0600	0.0891	0.0663	0.1325	0.0125	0.0071	0.0036	0.0083	0.0041	0.0145	0.0163	0.0808	0.0027	0.0350	0.0167	0.0250
8	0.1250	0.0750	0.1113	0.0828	0.1657	0.0157	0.0089	0.0045	0.0103	0.0052	0.0182	0.0204	0.1010	0.0030	0.0438	0.0209	0.0312
6	0.1667	0.1000	0.1485	0.1105	0.2209	0.0209	0.0119	0.0060	0.0138	0.0069	0.0242	0.0272	0.1347	0.0035	0.0583	0.0278	0.0417
5	0.2000	0.1200	0.1781	0.1325	0.2651	0.0251	0.0143	0.0071	0.0165	0.0083	0.0291	0.0326	0.1616	0.0038	0.0700	0.0334	0.0500
4	0.2500	0.1500	0.2227	0.1657	0.3314	0.0314	0.0178	0.0089	0.0207	0.0103	0.0363	0.0408	0.2020	0.0043	0.0875	0.0418	0.0625
3	0.3333	0.2000	0.2969	0.2209	0.4418	0.0418	0.0238	0.0119	0.0275	0.0138	0.0484	0.0544	0.2693	0.0049	0.1167	0.0557	0.0833
2.5	0.4000	0.2400	0.3563	0.2651	0.5302	0.0502	0.0286	0.0143	0.0330	0.0165	0.0581	0.0653	0.3232	0.0054	0.1400	0.0668	0.1000
2	0.5000	0.3000	0.4453	0.3314	0.6627	0.0627	0.0357	0.0178	0.0413	0.0206	0.0727	0.0816	0.4040	0.0060	0.1750	0.0835	0.1250
1.5	0.6667	0.4000	0.5938	0.4418	0.8837	0.0836	0.0476	0.0238	0.0551	0.0275	0.0969	0.1088	0.5387	0.0070	0.2333	0.1113	0.1667
1.25	0.8000	0.4800	0.7125	0.5302	1.0603	0.1003	0.0571	0.0286	0.0661	0.0330	0.1163	0.1305	0.6464	0.0076	0.2800	0.1336	0.2000
1	1.0000	0.6000	0.8906	0.6627	1.3254	0.1254	0.0714	0.0357	0.0826	0.0413	0.1453	0.1632	0.8080	0.0085	0.3500	0.1670	0.2500

[a] For key to designation symbols, see Section 4
[b] See Section 4, note a
[c] Applies to formulas for major and minor diameter in Section 4
[d] See paragraph 6.1
[e] See paragraph 11.1 (c) and 11.2 (b)
[f] See paragraph 11.3



0.5G = 0.5 Pitch Diameter Allowance on External Thread
s = Root Truncation
s(Max) = 0.0826p
s(Min) = 0.0413p

FIG. 2 DISPOSITION OF BUTTRESS THREAD TOLERANCES, ALLOWANCES, AND ROOT TRUNCATIONS
(Heavy line indicates basic form)

Table 3 Tolerances, Class 2 (Standard Grade)

Threads per Inch	Pitch[a], p	Basic Major Diameter									Pitch[b] Increment, $0.0173\sqrt{p}$
		From 0.5 thru 0.7	Over 0.7 thru 1.0	Over 1.0 thru 1.5	Over 1.5 thru 2.5	Over 2.5 thru 4	Over 4 thru 6	Over 6 thru 10	Over 10 thru 16	Over 16 thru 24	
		Tolerance on major diameter of external thread, pitch diameter of external and internal thread, and minor diameter of internal thread.									
1	2	3	4	5	6	7	8	9	10	11	12
20	0.0500	0.0056									0.00387
16	0.0625	0.0060	0.0062	0.0065	0.0068	0.0073					0.00432
12	0.0833	0.0067	0.0069	0.0071	0.0075	0.0080	0.0084				0.00499
10	0.1000		0.0074	0.0076	0.0080	0.0084	0.0089	0.0095	0.0102		0.00547
8	0.1250			0.0083	0.0086	0.0091	0.0095	0.0101	0.0108	0.0115	0.00612
6	0.1667			0.0092	0.0096	0.0100	0.0105	0.0111	0.0118	0.0125	0.00706
5	0.2000				0.0103	0.0107	0.0112	0.0117	0.0124	0.0132	0.00774
4	0.2500				0.0112	0.0116	0.0121	0.0127	0.0134	0.0141	0.00865
3	0.3333						0.0134	0.0140	0.0147	0.0154	0.00999
2.5	0.4000							0.0149	0.0156	0.0164	0.01094
2.0	0.5000							0.0162	0.0169	0.0177	0.01223
1.5	0.6667								0.0188	0.0196	0.01413
1.25	0.8000								0.0202	0.0209	0.01547
1.0	1.0000									0.0227	0.01730
Diameter Increment,[c] $0.002\sqrt[3]{D}$		0.00169	0.00189	0.00215	0.00252	0.00296	0.00342	0.00400	0.00470	0.00543	

[a] For threads with pitches not shown in this table, pitch increment to be used in tolerance formula is to be determined by use of formula, see par. 6.1.

[b] See paragraph 6.1.

[c] See paragraph 6.1. Diameter, D, used in diameter increment formula, is based on the average of the range.

Table 4 Tolerances, Class 3 (Precision Grade)

Threads, per Inch	Pitch, *p*	Basic Major Diameter								
		From 0.5 thru 0.7	Over 0.7 thru 1.0	Over 1.0 thru 1.5	Over 1.5 thru 2.5	Over 2.5 thru 4	Over 4 thru 6	Over 6 thru 10	Over 10 thru 16	Over 16 thru 24
		Tolerance on major diameter of external thread, pitch diameter of external and internal threads, and minor diameter of internal thread								
1	2	3	4	5	6	7	8	9	10	11
20	0.0500	0.0037								
16	0.0625	0.0040	0.0042	0.0043	0.0046	0.0049				
12	0.0833	0.0044	0.0046	0.0048	0.0050	0.0053	0.0056			
10	0.1000		0.0049	0.0051	0.0053	0.0056	0.0059	0.0063	0.0068	
8	0.1250			0.0055	0.0058	0.0061	0.0064	0.0067	0.0072	0.0077
6	0.1667			0.0061	0.0064	0.0067	0.0070	0.0074	0.0078	0.0083
5	0.2000				0.0068	0.0071	0.0074	0.0078	0.0083	0.0088
4	0.2500				0.0074	0.0077	0.0080	0.0084	0.0089	0.0094
3	0.3333						0.0089	0.0093	0.0098	0.0103
2.5	0.4000							0.0100	0.0104	0.0109
2.0	0.5000							0.0108	0.0113	0.0118
1.5	0.6667								0.0126	0.0130
1.25	0.8000								0.0135	0.0139
1.0	1.0000									0.0152

this latter formula, for various diameter pitch combinations are given in Tables 3 and 4.

6.1.1 *Functional Size.* Deviations in lead and flank angle of product threads increase the functional size of an external thread and decrease the functional size of an internal thread by the cumulative effect of the diameter equivalents of these deviations. The functional size of all buttress product threads shall not exceed the maximum-material-limit.

6.2 Tolerances on Major Diameter of External Thread and Minor Diameter of Internal Thread

Unless otherwise specified, these tolerances should be the same as the pitch diameter tolerance for the class used.

6.3 Tolerances on Minor Diameter of External Thread and Major Diameter of Internal Thread

It will be sufficient in most instances to state only the maximum minor diameter of the external thread and the minimum major diameter of the internal thread without any tolerance. However, the root truncation from a sharp V should not be greater than $0.0826p$ or less than $0.0413p$.

6.4 Lead and Flank Angle Deviations for Class 2

The deviations in lead and flank angles may consume the entire tolerance zone between maximum and minimum material product limits given in Table 3.

6.5 Diameter Equivalents for Variations in Lead and Flank Angles for Class 3

The combined diameter equivalents of variations in lead (including helix deviations), and flank angle for Class 3, shall not exceed 50 percent of the pitch diameter tolerances given in Table 4 (see Appendix A).

6.6 Tolerances on Taper and Roundness

6.6.1 *Class 2 Tolerances.* There are no requirements for taper and roundness for Class 2 buttress screw threads.

6.6.2 *Class 3 Tolerances.* The major and minor diameter of Class 3 buttress thread shall not taper or be out of round to the extent that specified limits for major and minor diameter are exceeded. The taper and out of roundness of the pitch diameter for Class 3 buttress threads shall not exceed 50 percent of the pitch diameter tolerances.

7 ALLOWANCE FOR EASY ASSEMBLY

An allowance (clearance) should be provided on all external threads to secure easy assembly of parts. The amount of the allowance is deducted from the nominal major, pitch and minor diameters of the external thread in order to determine the maximum material condition of the external thread.

The minimum internal thread is basic.

The amount of the allowance is the same for both classes and is equal to the Class 3 pitch diameter tolerance as calculated under par. 6.1. The allowances for various diameter-pitch combinations are given in Table 5.

The disposition of allowances and tolerances is shown in Fig. 2.

8 EXAMPLE SHOWING DIMENSIONS FOR A TYPICAL BUTTRESS THREAD (2 Inch Diameter, 4 TPI, 7°/45° Flank Angles, Class 2)

h = Basic thread height = 0.1500 (Table 2)

h_s = h_n = Height of thread in external and internal thread = 0.1657 (Table 2)

G = Pitch diameter allowance on external thread = 0.0074 (Table 5)

Tolerance on PD of external and internal threads = 0.0112 (Table 3)

Tolerance on major diameter of external thread and minor diameter of internal thread = 0.0112 (Table 3)

Internal Thread

Basic Major Diameter = D = 2.0000

Min Major Diameter = $D + 2h_n - 2h$ = 2.0314 (see Table 2, column 7)

Min Pitch Diameter = $D - h$ = 1.8500 (see Table 2)

Max Pitch Diameter = $D - h + PD$ Tol = 1.8612 (see Table 3)

Min Minor Diameter = $D - 2h$ = 1.7000 (see Table 2)

Max Minor Diameter = $D - 2h$ + Minor Diameter Tol = 1.7112 (see Tables 2 and 3)

External Thread

Max Major Diameter = $D - G$ = 1.9926 (see Table 5)

Min Major Diameter = $D - G$ − Major Diameter Tol = 1.9814 (see Tables 3 and 5)

Max Pitch Diameter = $D - h - G$ = 1.8426

Min Pitch Diameter = $D - h - G - PD$ Tol = 1.8314 (see Tables 3 and 5)

Max Minor Diameter = $D - G - 2h_s$ = 1.6612 (see Tables 2 and 5)

9 THREAD DESIGNATIONS

When only the designation, BUTT is used, the thread is "pull" type buttress (external thread pulls) with the clearance flank leading and the pressure flank 7° following. When the designation, PUSH-BUTT is used, the thread is a push type buttress (external thread pushes) with the load flank 7° leading the 45° clearance flank following. Whenever possible this description should be confirmed by a simplified view showing thread angles on the drawing of the product that has the buttress thread.

9.1 Thread Designation Abbreviations

In thread designations on drawings, tools, gages, and in specifications, the following abbreviations and letters are to be used:

BUTT	for buttress thread, pull type
PUSH-BUTT	for buttress thread, push type
LH	for left-hand thread (Absence of LH indicates that the thread is a right-hand thread.)
P	for pitch
L	for lead
A	for external thread
B	for internal thread

NOTE: Absence of A or B after thread class indicates that designation covers both the external and internal thread.

Le	for length of thread engagement
SPL	for special
FL	for flat root thread
E	for pitch diameter
TPI	for threads per inch
THD	for thread

9.2 Designations for Standard Threads

A buttress thread is considered to be *standard* when

(a) opposite flank angles are 7° and 45°

(b) basic thread height is 0.6p

(c) tolerances and allowances are as shown in Tables 3 through 5

(d) length of engagement is 10p or less.

9.2.1 *Designations for Single-Start Standard Threads*

- Right-hand (since LH not specified)
- Internal member to pull (since push is not specified)
- Radiused root of thread (since FL is not specified)

2.5-8 BUTT-2A

2.5-8 PUSH-BUTT-2A-LH-FL

- Flat root thread
- Left-hand
- External thread
- Class 2 thread
- Buttress form of thread
- Internal member to push
- Thread per inch
- Nominal size (basic major diameter of internal thread in inches (see Fig. 1a)

9.2.2 *Designations for Multiple-Start Standard Threads*

10- 0.25P- 0.5L – BUTT-3B (2 START)

- Internal thread
- Right-hand (since LH not specified)
- Class 3
- 0.5 inch lead (2 start since lead is twice the pitch)
- 4 threads per inch
- Nominal size in inches

Table 5 Allowances, Classes[a] 2 and 3

Threads per Inch	Pitch, *p*	Basic Major Diameter								
		From 0.5 thru 0.7	Over 0.7 thru 1.0	Over 1.0 thru 1.5	Over 1.5 thru 2.5	Over 2.5 thru 4	Over 4 thru 6	Over 6 thru 10	Over 10 thru 16	Over 16 thru 24
		Allowance on Major, Minor and Pitch Diameters of External Thread								
1	2	3	4	5	6	7	8	9	10	11
20	0.0500	0.0037								
16	0.0625	0.0040	0.0042	0.0043	0.0046	0.0049				
12	0.0833	0.0044	0.0046	0.0048	0.0050	0.0053	0.0056			
10	0.1000		0.0049	0.0051	0.0053	0.0056	0.0059	0.0063	0.0068	
8	0.1250			0.0055	0.0058	0.0061	0.0064	0.0067	0.0072	0.0077
6	0.1667			0.0061	0.0064	0.0067	0.0070	0.0074	0.0078	0.0083
5	0.2000				0.0068	0.0071	0.0074	0.0078	0.0083	0.0088
4	0.2500				0.0074	0.0077	0.0080	0.0084	0.0089	0.0094
3	0.3333						0.0089	0.0093	0.0098	0.0103
2.5	0.4000							0.0100	0.0104	0.0109
2.0	0.5000							0.0108	0.0113	0.0118
1.5	0.6667								0.0126	0.0130
1.25	0.8000								0.0135	0.0139
1.0	1.0000									0.0152

[a]See paragraph 7 for formula to calculate allowance for combinations not shown.

9.3 Superseded Designations

See Appendix D for the superseded designations.

10 MEASUREMENT OF BUTTRESS THREAD GAGES AND PRODUCT

Measuring the pitch diameter of buttress threads presents some difficulty because there is a wide difference between the angle of the load flank and the angle of the clearance flank. The clearance flank of 45° has a greater effect on the pitch diameter measurements (see last formula in Appendix A) than the 7° flank. Therefore, the clearance flank angle on thread gages should be held to at least as close as the tolerance on the load flank.

10.1 Pitch Diameter Determination of Threaded Plug Gages

The gages shall meet the tolerances given in Table 6. The groove diameter shall be measured with best size wires (see Appendix B and Table 11). The functional size of the gage, which is permitted to exceed the tolerance, may be obtained by adding the pitch diameter equivalents for the measured deviations in lead and flank angles to the measured groove diameter. Thus the maximum material limit of the threaded plug gage may take full advantage of the maximum permitted lead and flank angle deviations given in Table 6.

10.2 Pitch Diameter Determination of Threaded Ring Gages

The rings shall meet the tolerances given in Table 6 for lead and flank angles. Since rings are set to a setting plug, the pitch diameter values in Table 6 do not represent the pitch diameter of the gage as a separate element. Standard practice is to have the functional size of the ring based on the functional size of its setting plug. If the pitch or groove diameter is needed, one of the methods described in paragraph 10.4 may be used. Thread setting plug gages shall meet the tolerances in Table 7.

10.3 Pitch Diameter Determination of External Product Threads

Groove diameter may be measured by "best-size" wires as described in Appendix B (1) (see Table 11). If the thread flanks are of poor quality, inaccurate measurements result. If the product thread is a soft nonferrous material, the measuring force on the wires must be less than 2½ lbs to avoid brinelling the threads and unreliable measurements. The following maximum flank angle deviations will not produce errors greater than 0.0005 inch in pitch diameter when using *C* constants for "best-size" wires: 1° for 12 thru 20 TPI, 30′ for 6 thru 11 TPI, 15′ for 3 thru 5 TPI and 5′ for 1 and 2 TPI. For greater flank angle deviations formula 1 in Appendix B shall be used.

10.3.1 *Computed Functional Size of External Product Threads.* For computed functional size, add the diameter equivalents for measured lead and flank angles to the measured groove diameter. The computed functional size is not always reliable because combinations of deviations in lead, flank angle, taper and roundness tend to compensate each other.

10.4 Pitch Diameter Determination of Internal Product Threads

The pitch or groove diameter of internal product threads may be measured as described in Appendix B (2). If the internal product thread is a soft nonferrous material, the measuring force on the balls must be less than 2½ pounds to avoid brinelling the threads and unreliable measurements. If the thread flanks are poor quality, the measurement will not be accurate. Paragraph 10.3 states the limitation on using *C* constants for "best-size" wires and they apply to "best-size" balls.

10.4.1 *Computed Functional Size of Internal Product Threads.* For functional size subtract the diameter equivalents for lead and flank angles from the measured pitch or groove diameter. Computed functional size is not reliable as stated in 10.3.1.

10.5 Lead and Flank Angle Measurement

Paragraphs 11.1d and 11.1e provide information on the measurement of lead and flank angle.

11 RECOMMENDED GAGING PRACTICE

Buttress threads are employed for thrust purposes and it is essential to obtain as large a contact area as practicable between the load flanks of the threads of mating components. Therefore, differences in the angle of the load flanks and of pitch/lead in the length of engagement of mating components should be kept as small as possible. The clearance flank at 45° will normally clear when mating components are assembled. Close control of the 45° flank is necessary only when the 45° flank serves as a datum for tooling and inspection processes. Product that fits in or on GO thread gages, described later, will assemble.

11.1 Recommended Gages and Gaging Practice for External Thread

The recommended gages and gaging practice for the external thread follows.

(a) The major diameter of the external thread shall be checked by GO and NOT GO plain snap (caliper), indicating, or plain ring gages.

(b) The GO threaded ring, thread snap (caliper), or indicating thread gage shall have or be set to

Pitch diameter = max. pitch diameter of external thread with minus gagemaker's tolerance, as transferred from the set plug

Major diameter = to clear max. major diameter of external thread, see Section 4

Minor diameter = min. minor diameter of internal thread with minus gagemaker's tolerance.

(c) The NOT GO thread ring, snap (caliper), or indicating thread gage shall have or be set to

Pitch diameter = min. pitch diameter of external thread with plus gagemaker's tolerance, as transferred from the set plug

Major diameter = to clear max. major diameter of external thread, see Section 4

Minor diameter = min. pitch diameter of external thread minus 0.35p with plus gagemaker's tolerance.

The NOT GO screw ring gage, screwed by hand without using excessive force on the product thread, may enter both sides but not more than two turns of thread.

(d) The lead of Class 3A external threads shall be measured or gaged at intervals over the total length of engagement as specified in ANSI B1.2, paragraph 3.2.3.4. The measurement or gaging of lead on Class 2A external threads is optional.

(e) Both flank angles of gages and Class 3A external threads shall be determined either as specified in ANSI B1.2, paragraph 3.2.3.4, or by means of suitable templates or by thread profile tracing equipment. Flank angles may be measured on Class 2A threads.

(f) The GO thread setting plug gage for GO thread gages shall have

Pitch diameter = max. pitch diameter of external thread with minus gagemaker's tolerance

Major diameter (full form) = max. major diameter of external thread with plus gagemaker's tolerance

Major diameter (truncated) = max. major diameter of external thread minus 0.2p with minus gagemaker's tolerance

Minor diameter = to clear min. minor diameter of GO threaded ring gage, see Section 4.

(g) The NOT GO thread setting plug gage for NOT GO thread ring, snap (caliper) or indicating thread gage shall have

Pitch diameter = min. pitch diameter of external thread with plus gagemaker's tolerance

Major diameter (full form) = max. major diameter of external thread with plus gagemaker's tolerance

Major diameter (truncated) = max. major diameter of external thread minus 0.2p with minus gagemaker's tolerance

Minor diameter = to clear min. minor diameter specified in paragraph 11.1c, see Section 4.

(h) The root radius shall be checked with templates, radii charts by optical projection or microscope or by thread profile tracing equipment.

11.2 Recommended Gages and Gaging Practice for Internal Thread

The recommended gages and gaging practices for internal thread follows.

(a) The GO thread plug or indicating thread gage shall have or be set to

Pitch diameter = min. pitch diameter of internal thread with plus gagemaker's tolerance

Major diameter = max. major diameter of external thread with plus gagemaker's tolerance

Minor diameter = to clear min. minor diameter of internal thread, see Section 4.

(b) The NOT GO thread plug or the indicating thread gage shall have or be set to

Pitch diameter = max. pitch diameter of internal thread with minus gagemaker's tolerance

Major diameter = max. pitch diameter of internal thread plus 0.35p with minus gagemaker's tolerance

Minor diameter = to clear min. minor diameter of internal thread, see Section 4.

The NOT GO screw plug gage, screwed by hand without using excessive force, may enter into both ends of the internal product thread, but not more than two turns of thread.

(c) The lead of Class 3B internal thread shall be measured or gaged at intervals over the total length of engagement as specified in ANSI B1.2, paragraph 3.2.3.4, or by thread profile tracing equipment. The

Table 6 *X* Gagemaker's Tolerances for GO and NOT GO Buttress Threaded Plug, Ring, Snap and Indicating Gages

Threads per inch	Tolerance on pitch[a]	Tolerance on 7° and 45° flank angles of thread	Tolerance on major or minor diameters		Tolerance on pitch diameter						PD[b] Equiv.
			To and including 4 in nom dia	Above 4 in nom dia	To and including 1.5 in nom dia	Above 1.5 thru 4 in nom dia	Above 4 thru 8 in nom dia	Above 8 thru 12 in nom dia	Above 12 thru 18 in nom dia	Above 18 thru 24 in nom dia	All Sizes
1	2	3	4	5	6	7	8	9	10	11	12
	in.	min ±	in.	in.	in.	in.	in.	in.	in.	in.	in.
20	0.0003	15	0.0005	0.0007	0.0003	0.0004	0.0005				0.0009
16	0.0003	10	0.0006	0.0009	0.0003	0.0004	0.0006				0.0008
12	0.0003	10	0.0006	0.0009	0.0003	0.0004	0.0006				0.0009
10	0.0003	10	0.0006	0.0009	0.0003	0.0004	0.0006	0.0008	0.0012	0.0016	0.0010
8	0.0004	5	0.0007	0.0011	0.0004	0.0005	0.0006	0.0008	0.0012	0.0016	0.0010
6	0.0004	5	0.0008	0.0013	0.0004	0.0005	0.0006	0.0008	0.0012	0.0016	0.0011
5	0.0004	5	0.0008	0.0013		0.0005	0.0006	0.0008	0.0012	0.0016	0.0012
4	0.0004	5	0.0009	0.0015		0.0005	0.0006	0.0008	0.0012	0.0016	0.0013
3	0.0006	5		0.0020			0.0008	0.0010	0.0016	0.0020	0.0019
2.5	0.0006	5		0.0020			0.0008	0.0010	0.0016	0.0020	0.0019
2	0.0006	5		0.0020			0.0008	0.0010	0.0016	0.0020	0.0022
1.5	0.0008	5		0.0030				0.0012	0.0020	0.0024	0.0030
1.25	0.0008	5		0.0030				0.0012	0.0020	0.0024	0.0033
1	0.0008	5		0.0030				0.0012	0.0020	0.0024	0.0038

[a] Allowable variation in pitch between any 2 threads not farther apart than the length of the gage.

[b] Cumulative pitch diameter equivalent for maximum lead and maximum flank angle deviations $\delta (E_p + E_{\alpha_{12}})$.

Table 7 W Gagemaker's Tolerances for GO and NOT GO Buttress Threaded Setting Plug Gages

Threads per inch	Tolerance[a] on pitch	Tolerance on flank angles of thread		Tolerance on major or minor diameters		Tolerance on pitch diameter						PD[b] Equiv.
				To and including 4 in. dia	Above 4 in. dia	To and including 1.5 in. dia	Above 1.5 thru 4 in. dia	Above 4 thru 8 in. dia	Above 8 thru 12 in. dia	Above 12 thru 18 in. dia	Above 18 thru 24 in. dia	All Sizes
1	2	3		4	5	6	7	8	9	10	11	12
	in.	± min		in.	in.	in.	in.	in.	in.	in.	in.	
		7°	45°									
20	0.00015	15	8	0.0005	0.0007	0.00015	0.0002	0.00025	0.0003			0.0005
16	0.00015	10	8	0.0006	0.0009	0.0002	0.00025	0.0003	0.0004			0.0005
12	0.0002	10	6	0.0006	0.0009	0.0002	0.00025	0.0003	0.0004			0.0006
10	0.00025	10	6	0.0006	0.0009	0.0002	0.00025	0.0003	0.0004	0.0006	0.0008	0.0008
8	0.00025	5	5	0.0007	0.0011	0.0002	0.00025	0.0003	0.0004	0.0006	0.0008	0.0007
6	0.0003	5	5	0.0008	0.0013	0.0002	0.00025	0.0003	0.0004	0.0006	0.0008	0.0009
5	0.0003	5	4	0.0008	0.0013		0.00025	0.0003	0.0004	0.0006	0.0008	0.0010
4	0.0003	5	4	0.0009	0.0015		0.00025	0.0003	0.0004	0.0006	0.0008	0.0010
3	0.0004	5	4		0.0020			0.0004	0.0005	0.0008	0.0010	0.0014
2.5	0.0004	5	4		0.0020			0.0004	0.0005	0.0008	0.0010	0.0015
2	0.0004	5	4		0.0020			0.0004	0.0005	0.0008	0.0010	0.0017
1.5	0.0005	5	4		0.0030				0.0006	0.0010	0.0012	0.0021
1.25	0.0005	5	4		0.0030				0.0006	0.0010	0.0012	0.0023
1	0.0005	5	4		0.0030				0.0006	0.0010	0.0012	0.0027

[a] Allowable variation in pitch between any 2 threads not farther apart than the length of the gage.
[b] Cumulative pitch diameter equivalent for max. lead and max. flank angle deviations $\delta(E_p + E\alpha_{12})$.

measurement or gaging of lead on Class 2B internal threads is optional.

(d) Both flank angles of gages and Class 3B internal thread shall be determined by optical projection from casts of the thread or as specified in ANSI B1.2, paragraph 3.2.3.4, or by thread profile tracing equipment. Flank angles may be measured or checked on Class 2B.

(e) The minor diameter of the internal thread shall be checked by GO and NOT GO plain plug or indicating gages.

(f) Root radius of the internal thread shall be checked on a cast of the thread with templates or against radii charts by optical projection or microscope, or by thread profile tracing equipment.

11.3 Root Relief Width for Gages

A root relief width of $0.167p$ may be used for GO thread gages and $0.25p$ for NOT GO thread gages. This relief should be located so that the shoulders formed at intersection of relief and thread flanks will be approximately equidistant from the pitch line.

11.4 Gage Tolerances

X gagemaker's tolerances shall be used for threaded plug, ring, snap, and indicating gages. *W* gagemaker's tolerances shall be used for threaded setting plug gages. *Z* gagemaker's tolerances shall be used for plain plug, ring, and snap gages. These gagemaker's tolerances are shown in Tables 6, 7 and 8.

11.5 For other thread gaging details and general principles, see ANSI B1.2.

12 DIMENSIONAL ACCEPTABILITY OF BUTTRESS PRODUCT SCREW THREADS

General practice as to the dimensional acceptability of buttress product screw threads for Classes 2 and 3, as shown in Tables 3 and 4, shall be based on the following interpretation of limits of size and the disposition of tolerances shall be as shown in Fig. 2.

12.1 Dimensional Acceptability of Class 2 Buttress Product Threads

Dimensional acceptable Class 2 product threads shall have the minimum material pitch diameter, gaged by NOT GO ring, plug or snap gages, and the functional size, gaged by GO plug and ring gages, within the tolerances of the gages manufactured to the limits of Tables 3, 5, 6, 7 and 8. NOTE: The minimum material pitch diameter of buttress product threads, gaged by NOT GO threaded plug, ring or snap gages, may sometimes be found outside of tolerance if it is gaged as a separate individual element or with various indicating gages.

Table 8 Gagemaker's Tolerances for Plain Plug, Ring and Snap Gages

Size Range		Tolerances
Above	To and Including	*Z*
in.	in.	in.
0.029	0.825	0.00010
0.825	1.510	0.00012
1.510	2.510	0.00016
2.510	4.510	0.00020
4.510	6.510	0.00025
6.510	9.010	0.00032
9.010	12.010	0.00040
12.010	15.010	0.00050
15.010	19.010	0.00070
19.010	24.010	0.00100

12.2 Dimensional Acceptability of Class 3 Buttress Product Threads

Dimensionally acceptable Class 3 product threads shall have the minimum material limit (pitch diameter measurement by snap or indicating gages both using cone and Vee type limited length contacts near the pitch circle or groove diameter measured by wires or balls) and the functional size (gaged by GO ring or indicating gages having gage contacts which in length approximate the length of engagement and which in contour engage product thread flank to a height of $0.6p$) within tolerances specified in Table 4. Acceptable Class 3 product threads shall have either the diameter equivalents for lead and flank angle measured by indicating gages or the lead and flank angles measured on measuring machine and optical equipment for compliance with paragraphs 6.5 and Tables 9 and 10. Acceptable Class 3 product threads shall meet the taper and roundness requirements of paragraph 6.4. Major diameter and minor diameter may be gaged with plain plug and ring gages or measured with indicating gages for compliance to tolerances in Table 4.

12.2.1 *Gaging Class 3 Threaded Product for Dimensional Acceptability With Gage Lengths Less than the Length of Thread Engagement.* When the gage for functional size has less length of thread engagement than that of the Class 3 product thread, the gage does not provide a sufficient length of engagement check to assure the required functional size. In such instances, the effect of lead deviation for that portion of length of engagement not covered by the gage may be calculated from Table 9 and the effect on functional size as gaged may be increased for external threads or decreased for internal threads by the calculated amount (see 6.1 and ANSI B1.2., Par. F4).

Table 9 Pitch Diameter Equivalents[a] for Lead Deviations

$\Delta E_\ell = 1.781\ \delta_\ell$

Lead Deviation	PD Increment	Lead Deviation	PD Increment	Lead Deviation	PD Increment
0.00001	0.00002	0.00010	0.00018	0.00100	0.00178
0.00002	0.00004	0.00020	0.00036	0.00200	0.00356
0.00003	0.00005	0.00030	0.00053	0.00300	0.00534
0.00004	0.00007	0.00040	0.00071	0.00400	0.00712
0.00005	0.00009	0.00050	0.00089	0.00500	0.00890
0.00006	0.00011	0.00060	0.00107	0.00600	0.01069
0.00007	0.00012	0.00070	0.00125	0.00700	0.01247
0.00008	0.00014	0.00080	0.00142	0.00800	0.01425
0.00009	0.00016	0.00090	0.00160	0.00900	0.01603
				0.01000	0.01781

[a] To find the pitch diameter increment for a lead deviation not shown in the table, sum up the PD increments for each digit.

Example for lead deviation of 0.00432″

Lead Deviation	PD Increment
0.00400″	0.00712″
0.00030″	0.00053″
0.00002″	0.00004″
δ_ℓ = 0.00432″	ΔE_ℓ = 0.00769″

Table 10 Pitch Diameter Equivalents[a] for Flank Angle Deviations

$$\Delta E_{\alpha} = p\ [0.009\ \delta\alpha_2 + 0.019\ \delta\alpha_1]$$

$$\alpha_1 = 45^\circ \qquad \alpha_2 = 7^\circ$$

$\pm\ \delta_{\alpha_1}$	Pitch diameter increment for 45° flank deviation $\Delta E_{\alpha_1} = p\ (0.019\ \delta_{\alpha_1})$ Units in 0.001 inch													
Deg.														
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.1	0.10	0.12	0.16	0.19	0.24	0.32	0.38	0.48	0.63	0.76	0.95	1.27	1.52	1.90
0.2	0.19	0.24	0.32	0.38	0.48	0.63	0.76	0.95	1.27	1.52	1.90	2.53	3.04	3.80
0.3	0.28	0.36	0.48	0.57	0.71	0.95	1.14	1.42	1.90	2.28	2.85	3.80	4.56	5.70
0.4	0.38	0.48	0.63	0.76	0.95	1.27	1.52	1.90	2.53	3.04	3.80	5.07	6.08	7.60
0.5	0.48	0.59	0.79	0.95	1.19	1.58	1.90	2.38	3.17	3.80	4.75	6.33	7.60	9.50
0.6	0.57	0.71	0.95	1.14	1.42	1.90	2.28	2.85	3.80	4.56	5.70	7.60	9.12	11.40
0.7	0.66	0.83	1.11	1.33	1.66	2.22	2.66	3.32	4.43	5.32	6.65	8.87	10.64	13.30
0.8	0.76	0.95	1.27	1.52	1.90	2.53	3.04	3.80	5.07	6.08	7.60	10.13	12.16	15.20
0.9	0.86	1.07	1.42	1.71	2.14	2.85	3.42	4.28	5.70	6.84	8.55	11.40	13.68	17.10
1.0	0.95	1.19	1.58	1.90	2.38	3.17	3.80	4.75	6.33	7.60	9.50	12.67	15.20	19.00
Threads per inch	20	16	12	10	8	6	5	4	3	2.5	2	1.5	1.25	1
Pitch	0.050	0.062	0.083	0.100	0.125	0.167	0.200	0.250	0.333	0.400	0.500	0.667	0.800	1.000

[a]To find the pitch diameter increment for the 45° and 7° flank angle deviations for a given pitch thread, sum up the pitch diameter increment (interpolate if necessary) for the corresponding angular deviation found in this table.

Example: A 0.200 pitch buttress thread with flank angles 45° 24′ and 7° 15′

Flank	Deviation	PD Increment
45°	δ_{α_1} = 24′ = 0.4°	0.00152″
7°	δ_{α_2} = 15′ = 0.25°	0.00045″ (by interpolation)
		$\Delta E_{\alpha_{12}}$ = 0.00197″

(Continued)

Table 10 Continued

$\pm \delta_{\alpha_2}$	Pitch diameter increment for 7° flank angle deviation $\Delta E_{\alpha_2} = p\,(0.009\,\delta_{\alpha_2})$ Units in 0.001 inch													
Deg.														
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.1	0.04	0.06	0.08	0.09	0.11	0.15	0.18	0.23	0.30	0.36	0.45	0.60	0.72	0.90
0.2	0.09	0.11	0.15	0.18	0.22	0.30	0.36	0.45	0.60	0.72	0.90	1.20	1.44	1.80
0.3	0.13	0.17	0.22	0.27	0.34	0.45	0.54	0.68	0.90	1.08	1.35	1.80	2.16	2.70
0.4	0.18	0.22	0.30	0.36	0.45	0.60	0.72	0.90	1.20	1.44	1.80	2.40	2.88	3.60
0.5	0.22	0.28	0.38	0.45	0.56	0.75	0.90	1.12	1.50	1.80	2.25	3.00	3.60	4.50
0.6	0.27	0.34	0.45	0.54	0.68	0.90	1.08	1.35	1.80	2.16	2.70	3.60	4.32	5.40
0.7	0.32	0.39	0.52	0.63	0.79	1.05	1.26	1.58	2.10	2.52	3.15	4.20	5.04	6.30
0.8	0.36	0.45	0.60	0.72	0.90	1.20	1.44	1.80	2.40	2.88	3.60	4.80	5.76	7.20
0.9	0.40	0.51	0.68	0.81	1.01	1.35	1.62	2.02	2.70	3.24	4.05	5.40	6.48	8.10
1.0	0.45	0.56	0.75	0.90	1.12	1.50	1.80	2.25	3.00	3.60	4.50	6.00	7.20	9.00
Threads per inch	20	16	12	10	8	6	5	4	3	2.5	2	1.5	1.25	1
Pitch	0.050	0.062	0.083	0.100	0.125	0.167	0.200	0.250	0.333	0.400	0.500	0.667	0.800	1.000

APPENDIX A
Pitch Diameter Equivalents for Lead and Flank Angle Deviations

A.1 LEAD DEVIATIONS

A deviation in the lead of a buttress thread increases the functional size of an external thread and decreases the functional size of an internal thread.

If $\delta \ell$ represents the maximum deviation in the axial displacement (lead deviation) between any two points on a buttress thread within the length of engagement, the corresponding increase in functional size of the external thread (or decrease for the internal thread) is given by the expression:

Change in functional size equals

$$\Delta E_{\ell} = \frac{2\,\delta \ell}{\tan 45^\circ + \tan 7^\circ} = 1.781\delta\ell$$

A.2 FLANK ANGLE DEVIATIONS

A deviation in one or both of the flank angles increases the functional size of an external thread and decreases the functional size of an internal thread.

If $\delta\alpha_1$ and $\delta\alpha_2$ (in degrees) represent the deviations present in the two flanks of a buttress thread, the corresponding change in functional size is given by the formula:

$$\Delta E\alpha_{12} = 0.6p \left[\frac{\pm \tan(7^\circ \pm \delta\alpha_2) \mp \tan 7^\circ}{\tan(7^\circ \pm \delta\alpha_2) + \tan 45^\circ} + \frac{\pm \tan(45^\circ \pm \delta\alpha_1) \mp \tan 45^\circ}{\tan(45^\circ \pm \delta\alpha_1) + \tan 7^\circ} \right]$$

The values of $\Delta E\alpha_{12}$ obtained by the above formula do not differ greatly for plus and minus values for $\delta\alpha_1$ and $\delta\alpha_2$, when $\delta\alpha_1$ and $\delta\alpha_2$ are one degree or less and the following formula, in which the signs are disregarded, gives values closely approximating the values obtained by the above formula:

$$\Delta E\alpha_{12} = p\,[0.009\,\delta\alpha_2 + 0.019\,\delta\alpha_1]$$

where $\delta\alpha_1$ and $\delta\alpha_2$ are in degrees or fractions of a degree.

A.3 COMPUTED FUNCTIONAL SIZE

Computation of functional size by addition for external threads (subtraction for internal threads) of the diameter equivalents for measured lead deviation and for the measured flank angle deviations to the pitch diameter measurement is not always reliable because various combinations of deviations in lead, flank angle, taper and roundness, tend to compensate for each other.

APPENDIX B
Pitch Diameter Measurement

B.1 MEASUREMENT OF PITCH DIAMETER OF EXTERNAL BUTTRESS THREADS

The pitch diameter of external buttress threads may be determined from measurements over wires of equal diameter of known size, which contact the flanks of the thread on opposite sides of the external thread. The measuring force is 2½ pounds for ferrous and hard materials. Two procedures are used in determining the pitch diameters from the readings over the wires, M_w.

a. The comparator reading M_w over the wires is checked using gage blocks as masters. Then, using the average diameter of the wires, w, as determined in accordance with ANSI B1.2, Appendix B.8 (except that variation in wire diameter is measured in 7°/45° buttress groove), the pitch diameter, E, is computed using the formula:

$$E = M_w + \frac{p}{\tan\alpha_1 + \tan\alpha_2} - w\left(1 + \operatorname{cosec}\frac{\alpha_1 + \alpha_2}{2}\cos\frac{\alpha_1 - \alpha_2}{2}\right) - c \qquad (1)$$

When $\alpha_1 = 45$ deg and $\alpha_2 = 7$ deg, this formula reduces to

$$E = M_w + 0.890643p - 3.156891w - c$$

or

$$E = M_w - C - c$$

where C is the wire constant and c is the lead-angle correction (see B.3).

For all diameter-pitch combinations in this standard, the largest lead-angle correction does not exceed 0.0007 inch.

The standard simplified practice for determining pitch diameter of a 7°/45° single start buttress thread is to use the following formula:

$$E = M_w - C$$

where the wire constant

$$C = -(0.890643P - 3.156891w)$$

Values for C_{best} and C_{max} are tabulated in Table 11.

b. In the optional method, a reading M_D is taken over the wires placed on either side of a plain cylindrical gage of known diameter D. Then, the distance T between the wires as seated in the threads of the thread plug is computed by the formula:

$$T = D - M_D + M_w$$

and the formula for pitch diameter E becomes:

$$E = T + \frac{p}{\tan\alpha_1 + \tan\alpha_2} - w\left(\operatorname{cosec}\frac{\alpha_1 + \alpha_2}{2}\cos\frac{\alpha_1 - \alpha_2}{2} - 1\right) - c \qquad (2)$$

or

$$E = T + 0.890643P - 1.156891w - c$$

D should be slightly smaller than the major diameter of the external thread to be measured.

B.2 MEASUREMENT OF PITCH DIAMETER AND GROOVE DIAMETER OF INTERNAL BUTTRESS THREADS

B.2.1 Measurement of internal pitch diameter and groove diameter by indicating gages

B.2.1.1 *Internal Pitch Diameter.* Internal pitch diameter may be measured with indicating gages using minimum flank contacts (approximately 0.1H) of the cone and Vee roll-type which engage at the mid-flank position. The indicating gage is set either to a master threaded ring gage which is set with the threaded setting plug gage or to setting plates consisting of two flat plates each with several ground 7°/45° form, parallel grooves for the proper pitch. The plates are spaced with gage blocks and the two grooved plates oriented to the lead-angle at the specified pitch diameter.

B2.1.2 *Internal Groove Diameter.* Internal groove diameter may be measured with indicating gages using floating ball gaging contacts which engage the thread for a length of 3½ pitches or less. The gage is set with

Table 11 Thread-Measuring Wires for 7°/45° Buttress Threads

Threads per Inch	Pitch, p	"Best" Wire					"Max" Wire		
		Diameter, $w_{best} = 0.54147p$	$j = 0.05281p$	$2j$	Projection, $a = 0.1094p$	$C_{best}^{a,b}$	Diameter, $w_{max} = 0.61433p$	Projection, $a' = 0.2244p$	$C_{max}^{a,b}$
1	2	3	4	5	6	7	8	9	10
20	0.05000	0.02707	0.00264	0.00528	0.0055	0.04093	0.03072	0.0112	0.05245
16	0.06250	0.03384	0.00330	0.00660	0.0068	0.05116	0.03840	0.0140	0.06556
12	0.08333	0.04512	0.00440	0.00880	0.0091	0.06822	0.05119	0.0187	0.08738
10	0.10000	0.05415	0.00528	0.01056	0.0109	0.08188	0.06143	0.0224	0.10486
8	0.12500	0.06768	0.00660	0.01320	0.0137	0.10233	0.07679	0.0280	0.13109
6	0.16667	0.09025	0.00880	0.01760	0.0182	0.13647	0.10239	0.0374	0.17476
5	0.20000	0.10829	0.01056	0.02112	0.0219	0.16369	0.12287	0.0449	0.20975
4	0.25000	0.13537	0.01320	0.02640	0.0274	0.20469	0.15358	0.0561	0.26217
3	0.33333	0.18049	0.01760	0.03520	0.0365	0.27288	0.20478	0.0748	0.34959
2.5	0.40000	0.21659	0.02112	0.04225	0.0438	0.32746	0.24573	0.0898	0.41949
2	0.50000	0.27074	0.02640	0.05281	0.0547	0.40938	0.30716	0.1122	0.52435
1.5	0.66667	0.36098	0.03521	0.07041	0.0729	0.54581	0.40955	0.1496	0.69914
1.25	0.80000	0.43318	0.04225	0.08450	0.0875	0.65499	0.49146	0.1795	0.83897
1	1.00000	0.54147	0.05281	0.10562	0.1094	0.81872	0.61433	0.2244	1.04873

[a] The C constants are used when the thread flanks are exact or may be used for small angle deviations. If the flank angle deviates to the limits given in Table 6, the C constants will introduce a maximum error of 0.0005" on the 1" pitch threads but only an insignificant error on 0.05" pitch threads. Use formula 1. for more exact values.

[b] There may be double contact of the measuring wires on the 7° flank if the lead-angle is more than a few degrees, therefore, it is desirable to check the pitch diameter measurement obtained with the "best" wires and with the "max" wires. If double contact occurs with both sets of wires, the pitch diameter must be checked with balls.

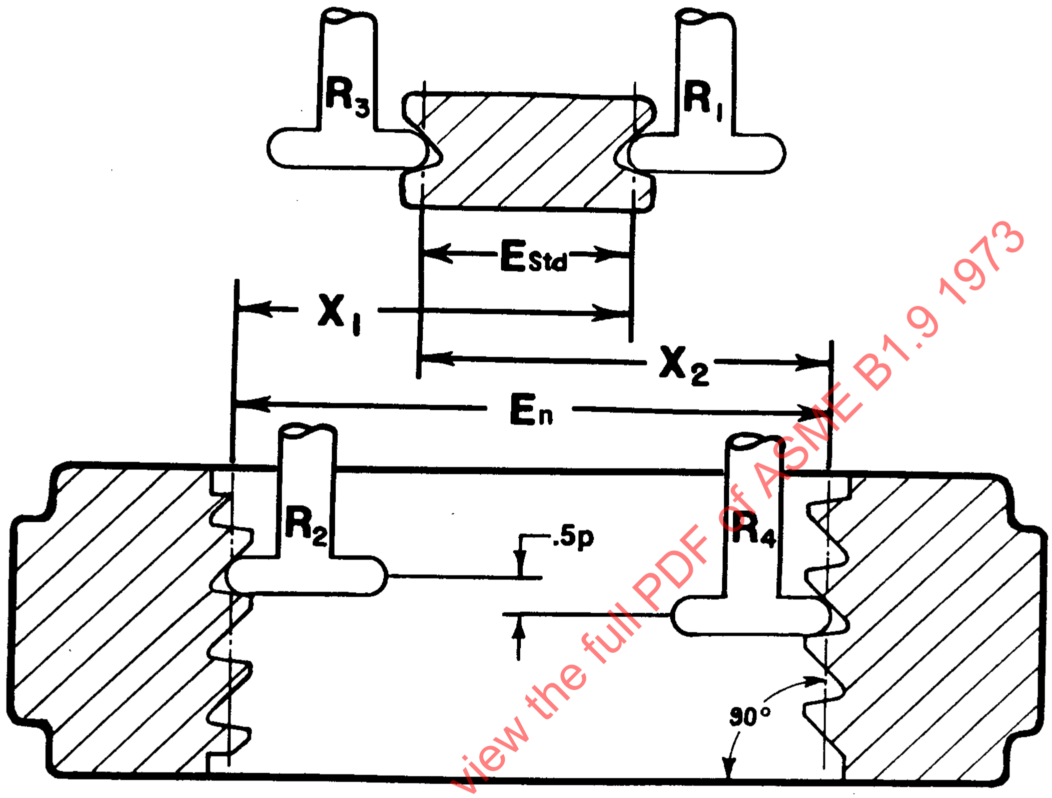


FIG. 3 MEASURING STEPS FOR INTERNAL PITCH DIAMETER

master plain ring gage, with micrometer or a gap established with two plane parallel jaws spaced with gage blocks. The measurement (M) over the balls for zero setting of the indicator is:

$$M = PD \text{ (basic)} + 2\,(w_{best} - 0.5C_{best} - j)$$

or

$$M = PD \text{ (basic)} + 2\,(w_{max} - 0.5C_{max})$$

Values for w_{best}, C_{best}, w_{max}, C_{max} and j are given in Table 11.

B.2.2 Measurement of Groove Diameter of Internal Buttress Threads

The groove diameter of an internal buttress thread may be determined by comparison with an external standard 7°/45° zero lead groove ground into a plain cylinder. The groove standard is calibrated for a groove diameter with the "best-size" pair of wires for the required pitch by the method used for external threads. A double-ended stylus with the ends radiused to match the "best-size" wire is used with a null indicator to obtain two readings (R_1 and R_3) on the standard groove and two readings (R_2 and R_4) on the internal thread or ring gage (see Fig. 3). The standard and the internal thread are mounted separately on the table on an XY coordinate measuring machine. From the four position readings the internal groove diameter, E_n, is calculated:

$$E_n = X_1 + X_2 - E_{Std}$$

Where X_1 is the measured distance between right side of 7°/45° groove standard and the left side of the selected internal thread, X_2 is the measured distance between the left side of the 7°/45° groove standard, and the right side of the corresponding selected internal thread and E_{Std} is the calibrated groove diameter of the 7°/45° groove standard.

B.3 LEAD-ANGLE CORRECTION

In both formulas (1) and (2), c is a correction depending on the angle the wires make with a plane perpendicular to the axis of the thread. For all combinations of diameters and pitches listed in Tables 3 and 4, in this standard, c is less than 0.0004 in., and it is recommended that the wire angle (lead-angle)