ASME/ANSI B1.12–1987

(REVISION OF ANSI B1.12–1972)

REAFFIRMED 1998

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PLEASE SEE ASME MANUAL AS-11

Class 5 Interference-Fit Thread

The American Society of Mechanical Engineers

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AN AMERICAN NATIONAL STANDARD

Class 5 Interference-Fit Thread

ASME/ANSI B1.12–1987

(REVISION OF ANSI B1.12–1972)

The American Society of Mechanical Engineers

345 East 47th Street, New York, N.Y. 10017

Date of Issuance: November 15, 1987

This Standard will be revised when the Society approves the issuance of a new edition. There will be no addenda or written interpretations of the requirements of this Standard issued to this edition.

FOREWORD

(This Foreword is not part of ASME/ANSI B1.12-1987.)

Interference-fit threads are threads in which the externally threaded member is larger than the internally threaded member when both members are in the free state and which, when assembled, become the same size and develop a holding torque through elastic compression, plastic movement of material, or both. By custom, these threads are designated as Class 5.

Tentative Class 5 fit threads were first published by the National Screw Thread Commission (1928), and alternate Class 5 appeared in the 1944 Handbook H28. These standards were helpful in stabilizing design; however, in spite of restrictive tolerances, loosening or breakage of externally threaded members has been all too frequent. Also, minimum and maximum torque values were established, the validity of which has been generally accepted.

The tentative and alternate standards, which were based on National Bureau of Standards and industry research, testing, and field study, represent the first attempt to establish an American standard for interference-fit threads. These specifications are published in Appendix A. In 1947, ASA Sectional Committee B1 on Screw Threads established Subcommittee 10 under the chairmanship of Harry Marchant to study the problems of interference fits. A subgroup of the subcommittee, chaired by W. S. Brown, conducted a comprehensive survey of design, production, and driving practices in the automotive, implement, railroad, and fastener industries and found that all were experiencing difficulty. Typical problems were:

(*a*) the variety of materials and heat treatments used for externally threaded members;

(*b*) variations resulting from rolling, cutting, or grinding external threads;

(*c*) the huge variety of chemical analyses and physical and mechanical properties encountered in the forged, cast, die cast, and rolled materials into which the externally threaded members are driven;

(*d*) the widely varying effects of chemical coatings, platings, and lubricants; and

(*e*) the inability to closely control sizes of tapped holes in various materials.

It was impossible to establish a standard at that time, but it was agreed that interference-fit threads could not be eliminated in design of equipment and that a workable standard was essential.

In 1951, Subcommittee 10, later renumbered 12, established a research subgroup which conducted extensive tests under a variety of conditions. The work of this research subgroup and a report of subsequent research and field experience is described in the article "New Class 5 Interference Fit Thread" by W. G. Waltermire, which appeared in the September 6, 1956 issue of *Machine Design*.

This Trial American Standard was predicated on the following conclusions, which were drawn from the research and field experience for developing holding torque through plastic movement of materials.

(*a*) Materials of the external and internal interference-fit threads compress elastically and flow during assembly and when assembled.

(*b*) During driving, plastic flow of materials occurs, resulting in either an increase of the external thread major diameter or a decrease in the internal thread minor diameter, or both.

(*c*) Relieving the external thread major diameter and the internal thread minor diameter to make allowance for plastic flow eliminates the main causes of seizing, galling, and abnormally high and erratic driving torques.

(*d*) Relieving the major diameter of external threads and minor diameter of internal threads requires an increase in the pitch diameter interference in order to obtain driving torques within the range established. (In driving studs, it was found that the minimum driving torque should be about 50% greater than the torque required to break loose a properly tightened nut.)

(*e*) Lubricating only the internal thread results in more uniform torques than lubricating only the external thread and is almost as beneficial as lubricating both external and internal threads. Some applications do not permit lubrication.

(*f*) For threads having truncated profile, torque increases directly as the pitch diameter interference for low interferences, but torque soon becomes practically constant and increases little, if at all, with increases of interference. Obviously, for uniformity of driving torques, it is desirable to work with greater interferences, resulting in plastic flow of materials.

(*g*) Comparatively large pitch diameter interferences can be tolerated, provided the external thread major diameter and internal thread minor diameter are adequately relieved and proper lubrication is used during assembly.

(*h*) Driving torque increases with turns of engagement, but levels off after the assembly is well advanced. (For thin wall applications, it may be desirable to use longer engagement and smaller pitch diameter interference to obtain desired driving torque.)

(*i*) Studs should be driven to a predetermined depth. Bottoming or shouldering must be avoided. *Bottoming*, which is engagement of the threads of the stud with the imperfect threads at the bottom of a shallow drilled and tapped hole, causes the stud to stop suddenly during power driving, thus inviting failure in torsional shear. Slipping clutches may permit transmission of excess torque. Bottoming can also damage parts having only a weak diaphragm at the bottom of the hole, through either mechanical or hydrostatic compression. *Shouldering*, which is the practice of driving the stud until the thread runout engages with the top threads of the hole, may create excessive radial compressive stresses and upward bulging of the material at the top of the hole. The torque, or stud holding power, produced by these radial compressive stresses is considerably relieved when the tensile load is applied to the stud, and may be inadequate to prevent backout in service.

The Trial American Standard was issued in November 1959. On October 23, 1961, the subcommittee reviewed the standard and recommended republication, without technical change, as an American Standard. It was felt that the lack of adverse comment after 2 years existence as a Trial Standard, and the reception of favorable comments of usage, warranted this step. On May 16, 1963, the standard was formally designated an American Standard. Several errors were discovered and B1.12 was rewritten. It was approved on September 5, 1972.

The most recent research on interference-fit thread was conducted by the Portsmouth Naval Shipyard on both hardened steel and nickel–copper–aluminum (K Monel) studs assembled in alloy steel (HY-80), corrosion resistant steel, nickel–copper (Monel), copper–nickel, and nickel–chromium (Inconel) internal threads, and on nonferrous studs in nonferrous internal threads. They modified the B1.12 Class 5 specifications for plastic flow interference-fit threads when nickel–copper–aluminum external threads are assembled in many materials. They also provided more cavity space. A summary of their findings for developing holding torque through plastic flow and elastic compression of material follows.

(*a*) Pitch diameter interferences specified in ANSI B1.12 were found to be too large, resulting in excessive failures.

(*b*) Lead, flank angles, taper, straightness, and roundness are important.

(*c*) Optimum surface roughness is 63 μin. Ra.

(*d*) Difference between functional size and pitch diameter of both the internal and external threads are measured and may not exceed 50% of the pitch diameter tolerances. (One foreign standard specifies 25%.)

(*e*) Critical applications require selective fits, using measured pitch diameters on the external and internal threads, to obtain a specified interference when the external and internal threads are assembled.

(*f*) Assembly torque cannot be continuous. Several waiting periods are required to let friction heat dissipate.

(*g*) Studs are indexed to monitor their movement. Assembly is considered a failure if there is stud rotation when seating the prevailing torque nut or breaking it away.

These Portsmouth Naval Shipyard thread specifications are published in Appendix B for elastic interference where permanent distortion is not desired and Appendix C for plastic flow interference with extra allowance at both the crest and root for K Monel.

This Standard was approved as an American National Standard on July 13, 1987.

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Standardization and Unification of Screw Threads

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CLASS 5 INTERFERENCE-FIT THREAD

1 GENERAL

1.1 Scope

This Standard provides dimensional tables for external and internal plastic flow interference-fit (Class 5) threads of modified National thread form in the coarse thread series (NC) in sizes 0.250 in. through 1.500 in. This is not the ANSI B1.1 UN thread form. It is intended that designs conforming with this Standard will provide adequate torque conditions which fall within the limits shown in Table 8. The minimum torques are intended to be sufficient to insure that externally threaded members will not loosen in service; the maximum torques establish a ceiling below which seizing, galling, or torsional failure of the externally threaded components is reduced. This Standard provides for the maximum allowable interference.

Appendices A, B, C, and D contain useful information that is supplementary to this Standard, such as reprints of the obsolete tentative and alternate Class 5 standards, U.S. Navy ship specifications for elastic interference-fit coarse thread series from 0.250 in. through 2.000 in., U.S. Navy ship specifications for Class 5 Modified which includes nickel–copper–aluminum alloy external threads, and an interference-metal comparison of standard to nonstandard interference-fit threads.

1.2 Field of Application

Interference-fit threads provide a high degree of resistance against turning of studs when prevailing torque nuts are used and against loosening of studs caused by load cycling and vibration. These threads are not intended for use where regular removal for component maintenance is required.

1.3 Reference Documents

1.3.1 American National Standards. The latest issues of the following standards form a part of this Standard to the extent specified herein.

ANSI B1.1
Unified Inch Screw Threads (UN and UNR Thread Form)

ANSI/ASME B1.2
Gages and Gaging for Unified Inch Screw Threads

ANSI/ASME B1.3M
Screw Thread Gaging Systems for Dimensional Acceptability—Inch and Metric Screw Threads (UN, UNR, UNJ, M, and MJ)

ANSI/ASME B1.7M
Nomenclature, Definitions, and Letter Symbols for Screw Threads

ANSI B94.9
Taps—Cut and Ground Threads

1.3.2 Other References

Metal Cutting Tool Institute.[1] *Taps, Ground Thread, Standards and Dimensions*. Cleveland, 1983.

Society of Manufacturing Engineers.[2] *Tool and Manufacturing Engineers Handbook—Volume 1, Machining*.

American Society for Metals.[3] *Metals Handbook—Volume 3, Machining*.

Metal Cutting Tool Institute.[1] *Metal Cutting Tool Handbook*.

Waltermire, W. G. ''New Class 5 Interference Fit Thread.'' *Machine Design* (September 6, 1956): 83–96.

1.4 Acceptability

Acceptability of product screw threads, based on the gaging method specified, shall be in accordance with ANSI/ASME B1.3M. Gages and gaging are in accordance with ANSI/ASME B1.2 but with gaging dimensions as specified in Tables 11 and 12. See paras. 11.1.1, 11.1.2, and 11.1.3.

[1]1230 Keith Building, Cleveland, Ohio 44115-2180.

[2]One SME Drive, P.O. Box 930, Dearborn, Michigan 48128.

[3]Metals Park, Ohio 44073.

1.5 Reference Temperature

The reference temperature is 68°F (20°C) for dimensions listed.

1.6 Units of Measure

All dimensions and values are expressed in inches unless otherwise noted.

1.7 Federal Government Use

When this Standard is approved by the Department of Defense and federal agencies and is incorporated into FED-STD-H28/23, Screw Thread Standards for Federal Services, Section 23, the use of this Standard by the federal government will be subject to all requirements and limitations of FED-STD-H28/23.

Appendices B and C are standard for U.S. Navy ship use.

2 TERMINOLOGY

2.1 General

For definitions, terms, and symbols relating to screw threads, see ANSI/ASME B1.7M.

2.2 Additional Definitions

breakaway or breakloose torque — torque required to start disassembly of the prevailing torque nut, or torque required to start disassembly of stud from internal threaded part

Class 5 fit — an interference-fit thread class used for interchangeable threaded members which are to be assembled by a turning force

elastic interference — an interference-fit assembly where the interference material zone is stressed within elastic limits. Upon disassembly, the thread profile usually has not been distorted.

ferrous material — iron and steel

galling — fracturing and tearing of the alloying mating surfaces and displacement of fractured metal particles during assembly or disassembly, caused by lack of lubrication, frictional heat, poor geometry of threads, and surface welding

lubricant — a liquid, powder, or mixture of both which permits assembly with a minimum of galling

lute — an ingredient of a lubricant such as graphite, rubber, white lead, molybdenum disulfide, or zinc dust

maximum driving torque — the maximum assembly torque derived from past experimentation which prevents torsional external thread failure

minimum driving torque — the minimum assembly torque for an acceptable assembly based on a torque which is 50% larger than the breakaway torque of the prevailing torque nut

plastic flow interference — an interference-fit assembly where part of the interference zone materials are permanently displaced beyond elastic limits. The external thread material tends to flow mostly toward its major diameter and the internal thread material tends to flow toward the minor diameter.

resin sealer — an anaerobic plastic cement used to glue and lock the assembly together where service temperatures do not exceed 200°F and interference tolerances are not met, where fire safety is not a factor, or where UN Class 3A and 3B threads are used

sealer — a lubricant which is insoluble in the medium being used

torque — the force required for rotation of the screw multiplied by the perpendicular distance from the axis of the screw (expressed in pound–inches or pound–feet)

3 THREAD DESIGNATIONS

The following examples of external and internal thread designations provide the means for distinguishing the present standard Class 5 thread from the obsolete tentative and alternate American National Class 5 threads which are given in Appendix A.

NOTE: ANSI/ASME B1.3M permits gaging systems to be designated in general notes, purchasing specifications, company standards, etc., in which case the individual designation of the thread designation may be omitted.

3.1 Class 5 External Thread

3.1.1 For Driving in Hard Ferrous Material With Brinell Hardness Over 160 HB

EXAMPLE: 0.500-13 NC-5 HF ( )

where

0.500 = nominal size
13 = threads per inch
N = American National thread form
C = coarse thread series
5 = Class 5 American National tolerance
HF = hard ferrous material, external thread
( ) = System 21, 22, or 23

3.1.2 For Driving in Copper Alloy and Soft Ferrous Material With Brinell Hardness of 160 HB or Less

EXAMPLE: 0.500-13 NC-5 CSF ( )

where

0.500 = nominal size
13 = threads per inch
N = American National thread form
C = coarse thread series
5 = Class 5 American National tolerance
CSF = copper alloy or soft ferrous material, external thread
( ) = System 21, 22, or 23

3.1.3 For Driving in Nonferrous Material Other Than Copper Alloys, Any Hardness

EXAMPLE: 0.500-13 NC-5 ONF ( )

where

0.500 = nominal size
13 = threads per inch
N = American National thread form
C = coarse thread series
5 = Class 5 American National tolerance
NF = other nonferrous material except copper alloy, external thread
( ) = System 21, 22, or 23

3.2 Class 5 Internal Thread

3.2.1 Entire Ferrous Material Hardness Range

EXAMPLE: 0.500-13 NC-5 IF ( )

where

0.500 = nominal size
13 = threads per inch
N = American National thread form
C = coarse thread series
5 = Class 5 American National tolerance
I = internal thread
F = entire ferrous material hardness range
( ) = System 21, 22, or 23

3.2.2 Entire Nonferrous Material Hardness Range

EXAMPLE: 0.500-13 NC-5 INF ( )

where

0.500 = nominal size
13 = threads per inch
N = American National thread form
C = coarse thread series
5 = Class 5 American National tolerance
I = internal thread
NF = entire nonferrous material hardness range
( ) = System 21, 22, or 23

4 SCREW THREAD PROFILE

The basic profile and design profiles are defined herein and are the bases for the thread dimensions in this Standard.

4.1 Basic Profile

The basic profile for National Class 5 interference threads is identical to the UN, UNR, and ISO 68 metric screw thread profile and is shown in Fig. 1.

4.2 Design Profiles

The design profiles define the maximum material conditions for external and internal threads and are derived from the basic profile.

4.2.1 Design Profile of External Threads. The design profile of external NC-5 screw threads is shown in Fig. 2. The crest is further truncated by adding an allowance to provide adequate cavity space for the displaced interference metal. Note that the NC-5 HF threads have the greater crest truncation.

The design profile of external NC-5 screw threads has flat crests and roots.

4.2.2 Design Profile of Internal Threads. The design profile of internal NC-5 screw threads is shown in Fig. 3.

4.3 Maximum and Minimum Interference

The maximum and minimum interference conditions for an assembly of 0.500-13 NC-5 HF hard ferrous external thread in a 0.500-13 NC-5 IF ferrous internal thread are illustrated in Fig. 4.

4.4 Formulas

Procedures to be applied to the basic profile for the limits of size of the National coarse series are given in Sections 7 and 8.

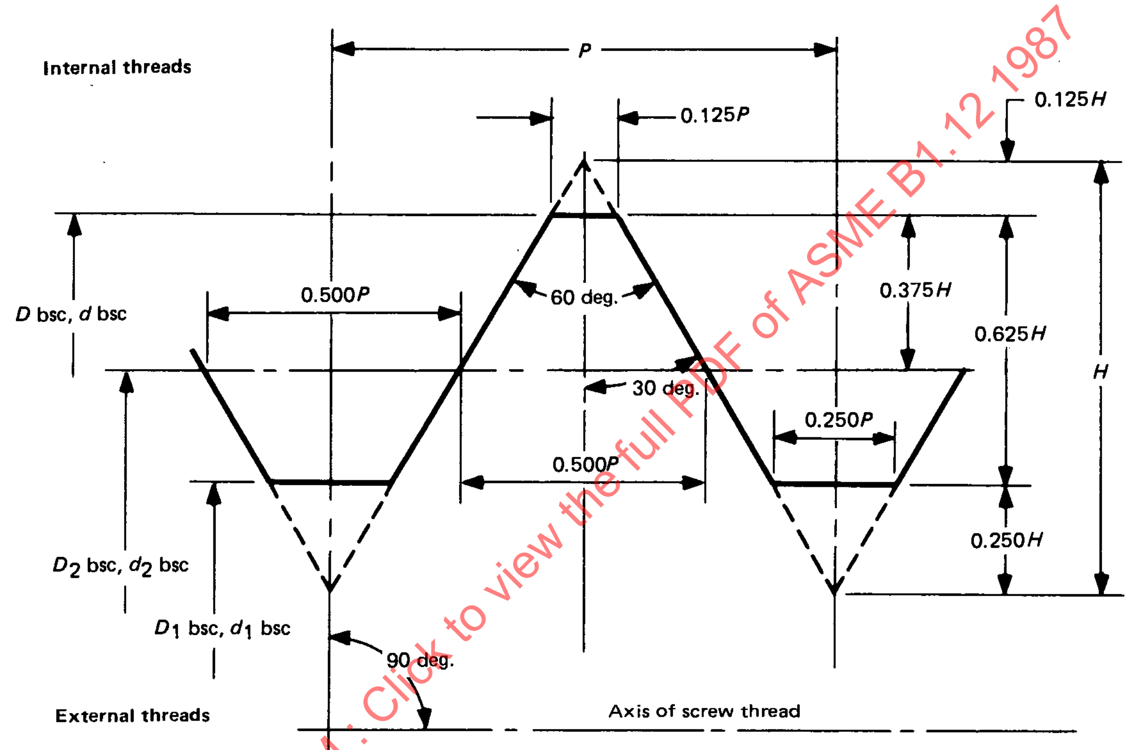
5 SCREW THREAD SERIES

5.1 Standard Series

The standard series consists of a coarse pitch series ranging from 0.250 in. through 1.500 in. (See Table 1.)

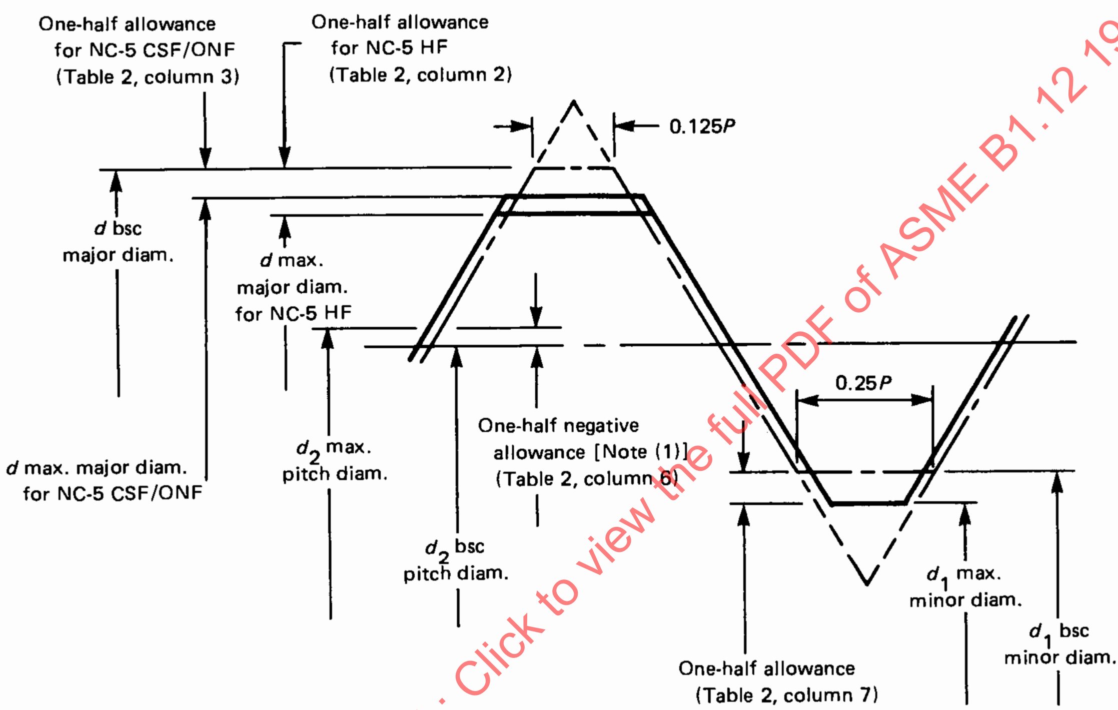
5.2 Fine Pitch Series

The fine pitch series is not part of this Standard and is not recommended.



$$H = (\sqrt{3}/2)\,P = 0.866\ 025P$$
$$0.125H = 0.108\ 253P$$
$$0.250H = 0.216\ 506P$$
$$0.375H = 0.324\ 760P$$
$$0.625H = 0.541\ 266P$$

FIG. 1 BASIC THREAD PROFILE



NOTE:
(1) Negative allowance is maximum interference.

FIG. 2 DESIGN PROFILE FOR EXTERNAL NC-5 HF/CSF/ONF THREAD (Maximum-Material Condition)

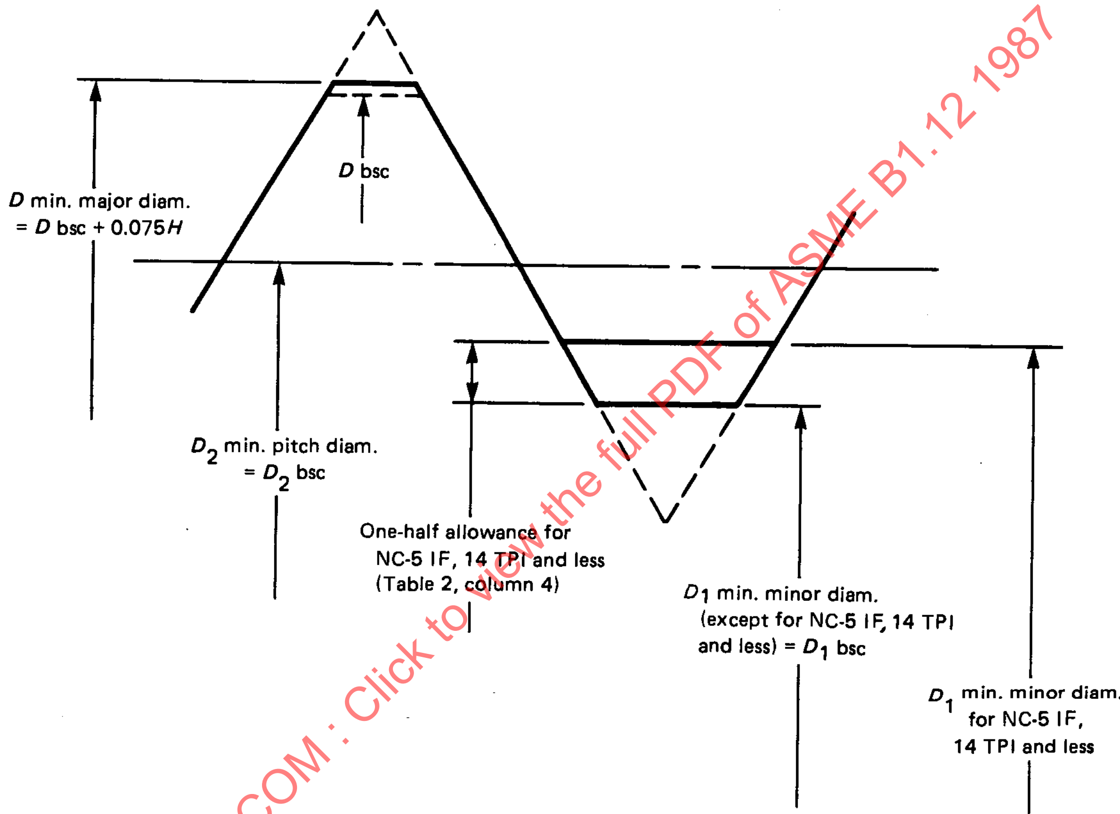
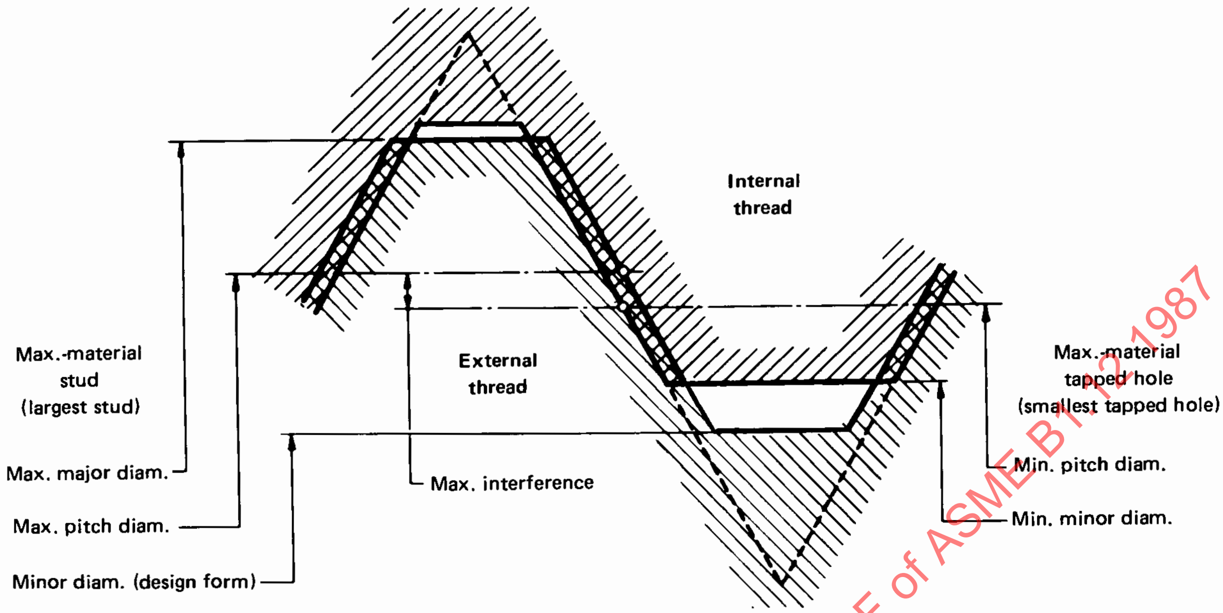
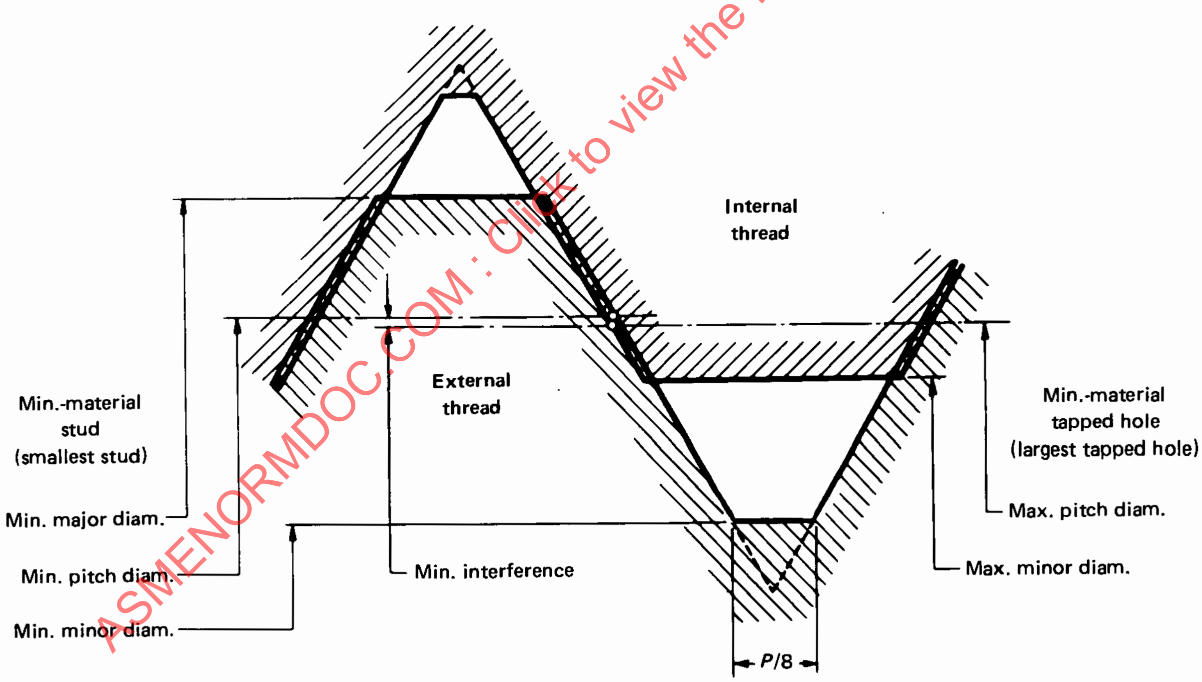


FIG. 3 DESIGN PROFILE FOR INTERNAL NC-5 IF/INF THREAD (Maximum-Material Condition)



(a) Maximum Interference



(b) Minimum Interference

GENERAL NOTES:
(a) 1/2-13 size is illustrated.
(b) Plastic flow of interference metal into cavities at major and minor diameter is not illustrated.

FIG. 4 MAXIMUM AND MINIMUM INTERFERENCE

TABLE 1 STANDARD NC-5 THREAD SERIES

1/4-20	or	0.2500-20	3/4-10	or	0.7500-10
5/16-18	or	0.3125-18	7/8- 9	or	0.8750- 9
3/8-16	or	0.3750-16	1 - 8	or	1.0000- 8
7/16-14	or	0.4375-14	1 1/8- 7	or	1.1250- 7
1/2-13	or	0.5000-13	1 1/4- 7	or	1.2500- 7
9/16-12	or	0.5625-12	1 3/8- 6	or	1.3750- 6
5/8-11	or	0.6250-11	1 1/2- 6	or	1.5000- 6

6 SCREW THREAD CLASS

The Class 5 interference fit was originally published as tentative by the National Screw Thread Commission in 1928. Over the years, some of the tolerances, diameters, and negative allowances (maximum interferences) have been modified in accordance with industry research.

7 SCREW THREAD ALLOWANCES AND TOLERANCES

7.1 Allowances

7.1.1 Pitch Diameter Allowance. A negative allowance (maximum pitch diameter interference) at maximum material is specified for the Class 5 external thread. Its purpose is to provide interference metal-to-metal contact to provide very high resistance to disassembly of the mated thread. (See Table 2.) There is no formula to generate the allowance.

7.1.2 Crest and Root Allowances. Crest and root allowances, tabulated in Table 2, such as differences between nominal size and maximum major diameter for external thread, between nominal size and minimum major diameter for internal thread (see General Notes to Table 2), between basic minor diameter and minimum minor diameter for internal thread, and between maximum minor diameter and basic minor diameter for external thread, provide cavity space at the major and minor diameters of Class 5 threads. These allowances are intended to reduce installation torques. These cavities accept displaced material from thread flank interference. (See para. 10.5.)

7.2 Tolerances

7.2.1 Pitch Diameter Tolerance. The pitch diameter tolerance for both internal and external threads is the same as for National Class 3. (See Table 3.) There is no formula to generate the National Class 3 pitch diameter tolerance.

7.2.2 Major Diameter Tolerance

7.2.2.1 External Threads. The major diameter tolerance for all external threads is twice the National Class 3 pitch diameter tolerance. (See Table 3.)

7.2.2.2 Internal Threads. The major diameter limits for all internal threads are the limits published by the Metal Cutting Tool Institute for the major diameter for ground thread taps, and are given in this Standard as a reference for the internal thread major diameter. These limits are used in the design of the tools that produce the internal thread major diameter. Acceptance of the internal thread major diameter is by the acceptance of the thread by a maximum material GO thread gage. (See Table 3 for tap major diameter tolerance.)

7.2.3 Minor Diameter Tolerance. The minor diameter tolerances for internal threads are tabulated in Table 3. For NC-5 IF threads with 20 through 16 TPI and 6 through 4 TPI, and for all NC-5 INF threads, the minor diameter tolerances are those for National Class 3 internal minor diameter rounded to three decimal places. Minor diameter tolerances for the remaining threads for NC-5 IF are one-sixth of $\frac{3}{4}H$ or $0.125H$ rounded to three decimal places.

8 STANDARD SERIES THREADS AND FORMULAS FOR LIMITS OF SIZE

8.1 Basic Dimensions for Standard Series Threads

The standard series for National Class 5 screw threads is listed in Table 1. Basic dimensions are given for coarse thread series in Table 4. Thread form data is given in Table 5. The limits of size are established by applying tolerances and allowances to the basic dimensions as indicated. These limits are the basis for measuring and gaging of the thread.

TABLE 2 ALLOWANCES FOR COARSE THREAD SERIES

TPI	Difference Between Nominal Size and Max. Major Diam. of NC-5 HF [Note (1)]	Difference Between Nominal Size and Max. Major Diam. of NC-5 CSF or NC-5 ONF [Note (1)]	Difference Between Basic Minor Diam. and Min. Minor Diam. of NC-5 IF [Note (1)]	Difference Between Basic Minor Diam. and Min. Minor Diam. of NC-5 INF	Maximum PD Interference or Negative Allowance, External Thread [Note (2)]	Difference Between Max. Minor Diam. and Basic Minor Diam., External Thread
1	2	3	4	5	6	7
20	0.0030	0.0030	0.000	0.000	0.0055	0.0072
18	0.0045	0.0035	0.000	0.000	0.0065	0.0080
16	0.0060	0.0040	0.000	0.000	0.0070	0.0090
14	0.0070	0.0045	0.014	0.000	0.0080	0.0103
13	0.0080	0.0050	0.014	0.000	0.0084	0.0111
12	0.0085	0.0050	0.016	0.000	0.0092	0.0120
11	0.0110	0.0055	0.017	0.000	0.0098	0.0131
10	0.0140	0.0060	0.019	0.000	0.0105	0.0144
9	0.0150	0.0065	0.022	0.000	0.0116	0.0160
8	0.0165	0.0065	0.025	0.000	0.0128	0.0180
7	0.0180	0.0070	0.030	0.000	0.0143	0.0206
6	0.0190	0.0070	0.034	0.000	0.0172	0.0241

GENERAL NOTE:
The difference between basic major diameter and internal thread minimum major diameter is 0.075H and is tabulated in Table 3, column 6.

NOTES:
(1) The allowance values in columns 2, 3, and 4 were obtained from industrial research data.
(2) Negative allowance is the difference between the basic pitch diameter and the pitch diameter value at maximum material.

TABLE 3 TOLERANCES FOR PITCH DIAMETER, MAJOR DIAMETER, AND MINOR DIAMETER FOR COARSE THREAD SERIES

TPI	Pitch Diameter Tolerance for External and Internal Thread [Note (1)]	Major Diameter Tolerance for External Thread [Note (2)]	Minor Diameter Tolerance for Internal Thread NC-5 IF	Minor Diameter Tolerance for Internal Thread NC-5 INF [Note (3)]	Tolerance 0.075H or 0.065P for Tap Major Diameter
1	2	3	4	5	6
20	0.0026	0.0052	0.010	0.010	0.0032
18	0.0030	0.0060	0.011	0.011	0.0036
16	0.0032	0.0064	0.011	0.011	0.0041
14	0.0036	0.0072	0.008	0.012	0.0046
13	0.0037	0.0074	0.008	0.012	0.0050
12	0.0040	0.0080	0.009	0.013	0.0054
11	0.0042	0.0084	0.010	0.013	0.0059
10	0.0045	0.0090	0.011	0.014	0.0065
9	0.0049	0.0098	0.012	0.014	0.0072
8	0.0054	0.0108	0.014	0.015	0.0081
7	0.0059	0.0118	0.015	0.015	0.0093
6	0.0071	0.0142	0.018	0.018	0.0108

NOTES:
(1) National Class 3 pitch diameter tolerance from ASA B1.1-1960 (see p. 85).
(2) Twice the NC-3 pitch diameter tolerance.
(3) National Class 3 minor diameter tolerance from ASA B1.1-1960 (see p. 85).

TABLE 4 BASIC DIMENSIONS FOR COARSE THREAD SERIES

Nominal Size	Basic Major Diameter D bsc, d bsc	TPI	Basic Pitch Diameter D_2 bsc, d_2 bsc	Basic Minor Diameter D_1 bsc, d_1 bsc
1/4	0.2500	20	0.2175	0.1959
5/16	0.3125	18	0.2764	0.2524
3/8	0.3750	16	0.3344	0.3073
7/16	0.4375	14	0.3911	0.3602
1/2	0.5000	13	0.4500	0.4167
9/16	0.5625	12	0.5084	0.4723
5/8	0.6250	11	0.5660	0.5266
3/4	0.7500	10	0.6850	0.6417
7/8	0.8750	9	0.8028	0.7547
1	1.0000	8	0.9188	0.8647
1 1/8	1.1250	7	1.0322	0.9704
1 1/4	1.2500	7	1.1572	1.0954
1 3/8	1.3750	6	1.2667	1.1946
1 1/2	1.5000	6	1.3917	1.3196

8.1.1 External Thread Formulas for Limits of Size

(*a*) (*1*) Maximum major diameter (d max.) for NC-5 HF equals basic major diameter (d bsc) minus allowance from Table 2, column 2.

(*2*) Maximum major diameter (d max.) for NC-5 CSF and NC-5 ONF equals basic major diameter (d bsc) minus allowance from Table 2, column 3.

(*b*) Minimum major diameter equals maximum major diameter (d max.) minus major diameter tolerance from Table 3, column 3.

(*c*) Maximum pitch diameter (d_2 max.) for all materials equals basic pitch diameter (d_2 bsc) plus negative allowance from Table 2, column 6.

(*d*) Minimum pitch diameter (d_2 min.) for all materials equals maximum pitch diameter (d_2 max.) minus pitch diameter tolerance from Table 3, column 2.

(*e*) Maximum minor diameter (d_1 max.) equals maximum pitch diameter (d_2 max.) minus $0.66667H$.

(*f*) Minimum minor diameter (d_1 min.) (reference only) equals minimum pitch diameter (d_2 min.) minus $0.75H$.

NOTE: This size is used in the design of tools. Acceptance of the minor diameter is by maximum material gage.

8.1.2 Internal Thread Formulas for Limits of Size

(*a*) Minimum major diameter (D min.) for all materials equals basic major diameter (D bsc) plus tolerance of $0.075H$ (Table 3, column 6). See Note in (b) below.

(*b*) Maximum major diameter (D max.) for all materials equals minimum major diameter (D min.) plus tolerance of $0.075H$ (Table 3, column 6).

NOTE: This size is used in the design of tools. Acceptance of the internal thread major diameter is by proper use of a maximum material GO thread gage.

(*c*) Minimum pitch diameter (D_2 min.) for all materials equals basic pitch diameter (D_2 bsc) for UN-3B.

(*d*) Maximum pitch diameter (D_2 max.) for all materials equals minimum pitch diameter (D_2 min.) plus pitch diameter tolerance from Table 3, column 2.

(*e*) (*1*) Minimum minor diameter (D_1 min.) for NC-5 INF equals basic minor diameter (D_1 bsc).

(*2*) Minimum minor diameter (D_1 min.) for NC-5 IF equals basic minor diameter (D_1 bsc) for sizes with more than 14 TPI. For 14 through 4 TPI use basic minor diameter (D_1 bsc) plus allowances tabulated in Table 2, column 4.

(*f*) (*1*) Maximum minor diameter (D_1 max.) for NC-5 INF equals minimum minor diameter (D_1 min.) plus minor diameter tolerance from Table 3, column 5.

(*2*) Maximum minor diameter (D_1 max.) for NC-5 IF equals minimum minor diameter (D_1 min.) plus minor diameter tolerance from Table 3, column 4.

9 THREAD CHARACTERISTICS

Tables 6, 7, and 8 are in compliance with the design and application data in Sections 8 and 10.

TABLE 5 THREAD CONSTANTS

TPI	Pitch	*H*	0.750*H*	0.666667*H*	0.500*H*	0.333333*H*	0.250*H*	0.166667*H*	0.15*H*	Truncation [Note (1)]
20	0.050000	0.043301	0.03248	0.02887	0.02165	0.01443	0.01083	0.00722	0.0065	0.00899
18	0.055556	0.048113	0.03608	0.03208	0.02406	0.01604	0.01203	0.00802	0.0072	0.00968
16	0.062500	0.054127	0.04060	0.03608	0.02706	0.01804	0.01353	0.00902	0.0081	0.01051
14	0.071429	0.061859	0.04639	0.04124	0.03093	0.02062	0.01546	0.01031	0.0093	0.01154
13	0.076923	0.066617	0.04996	0.04441	0.03331	0.02221	0.01665	0.01110	0.0100	0.01216
12	0.083333	0.072169	0.05413	0.04811	0.03608	0.02406	0.01804	0.01203	0.0108	0.01286
11	0.090909	0.078730	0.05905	0.05249	0.03936	0.02624	0.01968	0.01312	0.0118	0.01368
10	0.100000	0.086603	0.06495	0.05774	0.04330	0.02887	0.02165	0.01443	0.0130	0.01463
9	0.111111	0.096225	0.07217	0.06415	0.04811	0.03207	0.02406	0.01604	0.0144	0.01576
8	0.125000	0.108253	0.08119	0.07217	0.05413	0.03608	0.02706	0.01804	0.0162	0.01712
7	0.142857	0.123718	0.09279	0.08248	0.06186	0.04124	0.03093	0.02062	0.0186	0.01882
6	0.166667	0.144338	0.10825	0.09623	0.07217	0.04811	0.03608	0.02406	0.0217	0.02100

NOTE:
(1) Truncation for maximum-material truncated setting plug gage equals $0.06 \sqrt[3]{p^2} + 0.017p$.

9.1 Limits of Size

Limits of size for the national coarse series for 0.250 in. through 1.500 in. are given in Tables 6 and 7.

NOTE: Specifications for Class 5 Modified for K Monel external threads and usable for more materials are given in Appendix C.

9.2 Pitch Diameter Limits

9.2.1 External Thread. One set of pitch diameter limits is maintained for each size regardless of material. The minimum pitch diameter on external threads is larger than the basic pitch diameter of comparable unified coarse threads.

9.2.2 Internal Thread. One set of pitch diameter limits is maintained for each size regardless of material. The minimum pitch diameter on internal threads is the same as the basic pitch diameter of comparable unified coarse threads.

9.3 Major Diameter Limits

9.3.1 External Thread

(*a*) The major diameter of the external thread is less than the basic major diameter, which is based on a truncation of $H/8$. This reduction provides a spiral cavity between the major diameters of the external thread and internal thread where the interference material can flow. (See para. 9.4.2.)

(*b*) The hard ferrous materials and materials of similar hardness have a smaller major diameter than the soft ferrous and nonferrous materials.

9.3.2 Internal Thread

(*a*) The minimum major diameter of the internal thread is equal to the minimum tap major diameter. [See para. 8.1.2(a).]

(*b*) The maximum major diameter of the internal thread is nominally equal to the maximum major diameter of the tap. [See para. 8.1.2(b).]

9.4 Minor Diameter Limits

9.4.1 Internal Thread. The internal thread minor diameter limits are National Class 3 for all sizes in nonferrous materials and for sizes 0.0250 in. through 0.375 in. for ferrous materials. For 0.4375 in. and larger sizes in ferrous materials, the minor diameters have been enlarged slightly in order to reduce driving torques.

9.4.2 External Thread. The maximum minor diameter of the external thread is less than the basic minor diameter. This provides a cavity between the external and internal thread minor diameters for additional interference material flow. (See para. 9.3.1.)

9.5 Other Screw Thread Characteristics

Tables 1 and 2 in ANSI/ASME B1.3M identify the external and internal product screw thread characteristic(s), respectively, which singly or cumulatively change both the maximum and minimum interference conditions.

9.6 Length of Engagement

For driving into copper alloys and ferrous materials, the length of engagement is 1.25*D*. For driving into other nonferrous materials, the length of engagement is 2.5*D*. These are tabulated in Table 8.

Tolerances for length of full-form external thread and for minimum depth of full-form internal thread in hole are provided because the assembled external thread shall not bottom nor shall the unfinished threads engage. False torque and excessive stress occur if one or both of the above conditions exist. (See Fig. 5.)

10 NOTES ON PRODUCT DESIGN AND APPLICATION

10.1 Conditions of Usage

The following are for plastic flow interference-fit conditions on which satisfactory application of products made to dimensions in Tables 6 and 7 are predicated. Deviations from the dimensions and application notes may result in unsatisfactory performance. In the manufacture or inspection of product threads, control and verification of the limits of size and the various individual thread elements, using measurement methods, ensure that the threads produced will be acceptable. (See Appendix B for information on elastic interference fit.)

10.2 External Threaded Products

10.2.1 Coated Parts. Limits apply to bare or metallic coated parts.

10.2.2 Points. Points of externally threaded products should be chamfered or otherwise reduced to a diameter below the minimum minor diameter of the thread.

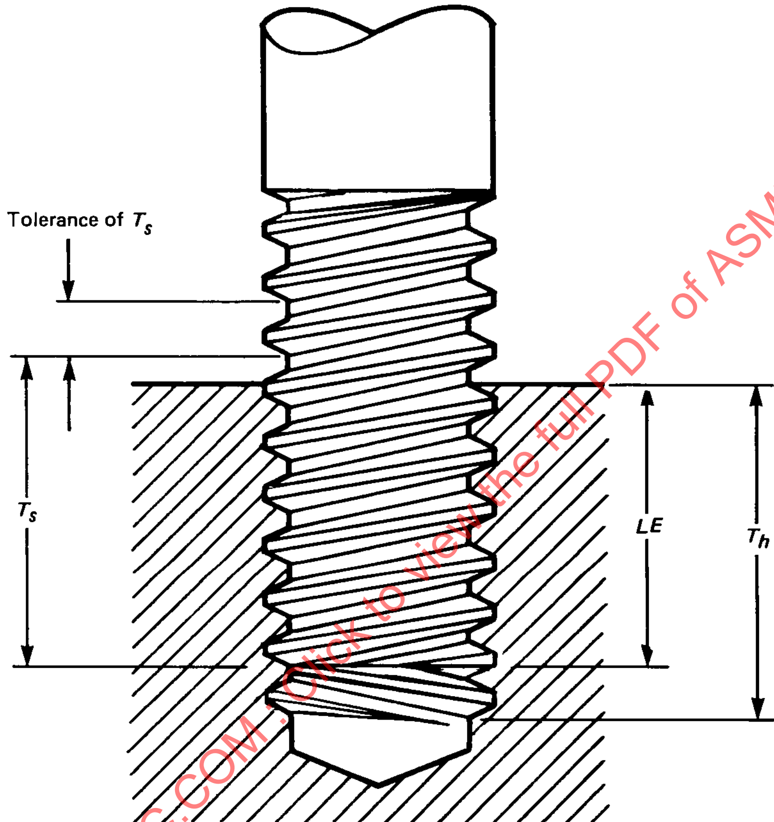


FIG. 5 ILLUSTRATION OF LE, T_s, TOLERANCE OF T_s, and T_h REQUIRED FOR ASSEMBLED THREADS
(To Prevent Bottoming of Stud in Hole, See Table 8)

TABLE 6 EXTERNAL THREAD DIMENSIONS FOR CLASS 5 STANDARD
(See Para. 10.2.3 for Application)

Nominal Size	Major Diameter: NC-5 HF for Driving in Ferrous Material With Hardness Over 160 HB *LE* = 1.25 Diam. [Notes (1), (2)]		Major Diameter: NC-5 CSF for Driving in Brass and Ferrous Material With Hardness 160 HB or Less *LE* = 1.25 Diam. [Notes (1), (2)]		Major Diameter: NC-5 ONF for Driving in Nonferrous Material Except Brass (Any Hardness) *LE* = 2.5 Diam. [Note (2)]		Pitch Diameter		Minor Diameter	
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min. (Ref.)
0.2500-20	0.2470	0.2418	0.2470	0.2418	0.2470	0.2418	0.2230	0.2204	0.1932	0.1879
0.3125-18	0.3080	0.3020	0.3090	0.3030	0.3090	0.3030	0.2829	0.2799	0.2508	0.2438
0.3750-16	0.3690	0.3626	0.3710	0.3646	0.3710	0.3646	0.3414	0.3382	0.3053	0.2976
0.4375-14	0.4305	0.4233	0.4330	0.4258	0.4330	0.4258	0.3991	0.3955	0.3579	0.3491
0.5000-13	0.4920	0.4846	0.4950	0.4876	0.4950	0.4876	0.4584	0.4547	0.4140	0.4047
0.5625-12	0.5540	0.5460	0.5575	0.5495	0.5575	0.5495	0.5176	0.5136	0.4695	0.4595
0.6250-11	0.6140	0.6056	0.6195	0.6111	0.6195	0.6111	0.5758	0.5716	0.5233	0.5126
0.7500-10	0.7360	0.7270	0.7440	0.7350	0.7440	0.7350	0.6955	0.6910	0.6378	0.6260
0.8750- 9	0.8600	0.8502	0.8685	0.8587	0.8685	0.8587	0.8144	0.8095	0.7503	0.7373
1.0000- 8	0.9835	0.9727	0.9935	0.9827	0.9935	0.9827	0.9316	0.9262	0.8594	0.8450
1.1250- 7	1.1070	1.0952	1.1180	1.1062	1.1180	1.1062	1.0465	1.0406	0.9640	0.9478
1.2500- 7	1.2320	1.2200	1.2430	1.2312	1.2430	1.2312	1.1715	1.1656	1.0890	1.0728
1.3750- 6	1.3560	1.3410	1.3680	1.3538	1.3680	1.3538	1.2839	1.2768	1.1877	1.1685
1.5000- 6	1.4810	1.4670	1.4930	1.4788	1.4930	1.4788	1.4089	1.4018	1.3127	1.2935

NOTES:
(1) 160 HB is standard Brinell number using 10 mm ball and 3000 kgf. This is approximately equivalent to Rockwell hardness B83 (83 HRB).
(2) See para. 9.6.

TABLE 7 INTERNAL THREAD DIMENSIONS FOR CLASS 5 STANDARD
(See Para. 10.2.3 for Application)

Nominal Size	NC-5 IF Ferrous Material: Min. Minor Diam.	NC-5 IF Ferrous Material: Max. Minor Diam.	NC-5 IF Ferrous Material: Tap Drill	NC-5 INF Nonferrous Material: Min. Minor Diam.	NC-5 INF Nonferrous Material: Max. Minor Diam.	NC-5 INF Nonferrous Material: Tap Drill	Pitch Diameter: Min.	Pitch Diameter: Max.	Major Diameter: Min.	Major Diameter: Max. [Note (1)]
0.2500-20	0.1960	0.2060	0.2031	0.1960	0.2060	0.2031	0.2175	0.2201	0.2532	0.2565
0.3125-18	0.2520	0.2630	0.2610	0.2520	0.2630	0.2610	0.2764	0.2794	0.3161	0.3197
0.3750-16	0.3070	0.3180	0.3160	0.3070	0.3180	0.3160	0.3344	0.3376	0.3790	0.3831
0.4375-14	0.3740	0.3810	0.3750	0.3600	0.3720	0.3680	0.3911	0.3947	0.4421	0.4468
0.5000-13	0.4310	0.4400	0.4331	0.4170	0.4290	0.4219	0.4500	0.4537	0.5050	0.5100
0.5625-12	0.4880	0.4970	0.4921	0.4720	0.4850	0.4844	0.5084	0.5124	0.5679	0.5733
0.6250-11	0.5440	0.5540	0.5469	0.5270	0.5400	0.5313	0.5660	0.5702	0.6309	0.6368
0.7500-10	0.6610	0.6780	0.6719	0.6420	0.6550	0.6496	0.6850	0.6895	0.7565	0.7630
0.8750- 9	0.7770	0.7890	0.7812	0.7550	0.7690	0.7656	0.8028	0.8077	0.8822	0.8894
1.0000- 8	0.8900	0.9040	0.8906	0.8650	0.8800	0.8750	0.9188	0.9242	1.0081	1.0162
1.1250- 7	1.0000	1.0150	1.0000	0.9700	0.9860	0.9844	1.0322	1.0381	1.1343	1.1436
1.2500- 7	1.1250	1.1400	1.1250	1.0950	1.1110	1.1094	1.1572	1.1631	1.2593	1.2686
1.3750- 6	1.2290	1.2470	1.2344	1.1950	1.2130	1.2031	1.2667	1.2738	1.3858	1.3967
1.5000- 6	1.3540	1.3720	1.3594	1.3200	1.3380	1.3281	1.3917	1.3988	1.5108	1.5217

NOTE:
(1) Reference, maximum major diameter of tap.

TABLE 8 INTERFERENCES, ENGAGEMENT LENGTHS, AND TORQUES FOR CLASS 5 STANDARD
(See Para. 10.2.3 for Application)

	Interferences on Pitch Diameter		Engagement Lengths, External Thread Lengths [Note (1)], and Tapped Hole Depths						Torque at 1.25*D* Engagement, Ferrous Material	
			In Brass and Ferrous Material			In Nonferrous Material Except Brass				
Nominal Size	Max.	Min.	*LE* [Note (2)]	T_s [Note (3)]	T_h [Note (4)]	*LE* [Note (2)]	T_s [Note (3)]	T_h [Note (4)]	Max., lb–ft	Min., lb–ft
0.2500-20	0.0055	0.0003	0.312	0.375 +0.125 −0.000	0.375	0.625	0.688 +0.125 −0.000	0.688	12	3
0.3125-18	0.0065	0.0005	0.391	0.469 +0.139 −0.000	0.469	0.781	0.859 +0.139 −0.000	0.859	19	6
0.3750-16	0.0070	0.0006	0.469	0.562 +0.156 −0.000	0.562	0.938	1.031 +0.156 −0.000	1.031	35	10
0.4375-14	0.0080	0.0008	0.547	0.656 +0.179 −0.000	0.656	1.094	1.203 +0.179 −0.000	1.203	45	15
0.5000-13	0.0084	0.0010	0.625	0.750 +0.192 −0.000	0.750	1.250	1.375 +0.192 −0.000	1.375	75	20
0.5625-12	0.0092	0.0012	0.703	0.844 +0.208 −0.000	0.844	1.406	1.547 +0.208 −0.000	1.547	90	30
0.6250-11	0.0098	0.0014	0.781	0.938 +0.227 −0.000	0.938	1.562	1.719 +0.227 −0.000	1.719	120	37
0.7500-10	0.0105	0.0015	0.938	1.125 +0.250 −0.000	1.125	1.875	2.062 +0.250 −0.000	2.062	190	60
0.8750- 9	0.0116	0.0018	1.094	1.312 +0.278 −0.000	1.312	2.188	2.406 +0.278 −0.000	2.406	250	90
1.0000- 8	0.0128	0.0020	1.250	1.500 +0.312 −0.000	1.500	2.500	2.750 +0.312 −0.000	2.750	400	125
1.1250- 7	0.0143	0.0025	1.406	1.688 +0.357 −0.000	1.688	2.812	3.094 +0.357 −0.000	3.094	470	155

TABLE 8 INTERFERENCES, ENGAGEMENT LENGTHS, AND TORQUES FOR CLASS 5 STANDARD (CONT'D)
(See Para. 10.2.3 for Application)

Nominal Size	Interferences on Pitch Diameter		Engagement Lengths, External Thread Lengths [Note (1)], and Tapped Hole Depths						Torque at 1.25D Engagement, Ferrous Material	
			In Brass and Ferrous Material			In Nonferrous Material Except Brass				
	Max.	Min.	LE [Note (2)]	T_s [Note (3)]	T_h [Note (4)]	LE [Note (2)]	T_s [Note (3)]	T_h [Note (4)]	Max., lb–ft	Min., lb–ft
1.2500- 7	0.0143	0.0025	1.562	1.875 $^{+0.357}_{-0.000}$	1.875	3.125	3.438 $^{+0.357}_{-0.000}$	3.438	580	210
1.3750- 6	0.0172	0.0030	1.719	2.062 $^{+0.419}_{-0.000}$	2.062	3.438	3.781 $^{+0.419}_{-0.000}$	3.781	705	250
1.5000- 6	0.0172	0.0030	1.875	2.250 $^{+0.419}_{-0.000}$	2.250	3.750	4.125 $^{+0.419}_{-0.000}$	4.125	840	325

NOTES:
(1) See Fig. 5.
(2) LE = length of engagement
(3) T_s = external thread length of full-form thread
(4) T_h = minimum depth of full-form thread in hole

10.2.3 Materials of Externally Threaded Ferrous Products. The length of engagement, depth of thread engagement, and pitch diameter in Tables 6 through 8 are designed to produce adequate torque conditions when heat-treated medium-carbon steel products, ASTM A 325 (SAE Grade 5) or better, i.e., minimum ultimate tensile strength of 145,000 psi, are used. In many applications, case-carburized products and nonheat-treated medium-carbon steel products, SAE Grade 4, are satisfactory. SAE Grades 1 and 2 may be usable under certain conditions. This Standard is not intended to cover the use of externally threaded products made of stainless steel, silicon bronze, brass, or similar materials. Where such materials are used, the dimensions listed herein will probably require adjustment based on pilot experimental work with the combination or materials involved.

10.2.4 Metal Flow. Metal flows into the major diameter cavity when hard studs are assembled into hard internal threads.

10.2.5 Cleanliness. Threads should be free from nicks, burrs, chips, grit, or other extraneous material before applying necessary lubricant and driving.

10.3 Internal Threaded Products

10.3.1 Countersinks. Holes should be countersunk to a diameter greater than the major diameter in order to facilitate starting of the externally threaded product and to prevent raising a lip around the hole after driving due to insufficient cavity space at major diameter.

10.3.2 Taper. Internal tapered threads with smaller diameter at the entering end tend to break loose when stud is started.

10.3.3 Metal Flow. Metal flows into the minor diameter cavity when hard external threads are assembled into soft internal threads.

10.3.4 Cleanliness. Holes should be free from nicks, burrs, chips, grit, or other foreign material before driving studs or screws.

10.4 Lead and Angle Variations

The lead variation values tabulated in Table 9 are the maximum variations from specified lead between any two points not farther apart than the length of the standard GO thread gage. Flank angle variation values tabulated in Table 10 are maximum variations from the basic 30 deg. angle between thread flanks and perpendiculars to the thread axis.

10.4.1 Stress on Thread Flank. Lead variation does not change the volume of displaced metal, but it exerts a cumulative unilateral stress on the pressure side of the thread flank. For a 1/4-20 thread assembly at maximum-material condition with a lead variation equivalent to one-half of the pitch diameter tolerance, an additional 8% of the displaced metal is forced onto the pressure flanks. For 1 1/2-6 threads, the figure is 5%.

10.4.2 Control. Control of the difference between pitch diameter size and functional diameter size to within one-half the pitch diameter tolerance will hold lead and angle variables to within satisfactory limits. Both of the variations may produce unacceptable torque and faulty assemblies. (See para. 11.2.2.)

10.5 Cavity Space for Interference Material

Calculations show that for the three small sizes of ferrous and all sizes of nonferrous material, cavity spaces at maximum interference are far less than the volumes of the interference metal displaced. When there is not sufficient reservoir for the escape of interference material, the probability of assembly failure is higher. (See Appendix D, Section D2.)

For consistency in assembly, selection of mating parts within the tolerance ranges to provide less interference may be necessary so that more space is available.

10.6 Thread Axis Position

A perfect thread has a common axis for the major diameter cylinder, the minor diameter cylinder, and the pitch diameter cylinder. Interference-fit thread assemblies of imperfect threads may have three axes either parallel or skew to each other, resulting in erratic torquing, excessive unilateral stress, nonuniform change in interference metal during assembly, and uneven available cavity space for metal to flow into, even though the interference metal displaced remains the same.

The circular runout (full-indicator movement) of the pitch and crest diameters over the thread length shall not exceed one-half the pitch diameter tolerance for the external or internal threaded products.

10.7 Surface Roughness

Surface roughness is not a required measurement. Roughness between 63 μin. and 125 μin. Ra is recommended. Surface roughness greater than 125 μin. Ra may encourage galling and tearing of threads. Surfaces with roughness less than 63 μin. Ra may hold insufficient lubricant and wring or weld together.

TABLE 9 MAXIMUM ALLOWABLE VARIATIONS IN LEAD AND MAXIMUM EQUIVALENT CHANGE IN FUNCTIONAL DIAMETER (See Para. 10.4 and Section 11 for Application)

Nominal Size	External and Internal Threads	
	Allowable Variation in Axial Lead (Plus or Minus)	Maximum Equivalent Change in Functional Diameter (Plus for External, Minus for Internal)
0.2500-20	0.0008	0.0013
0.3125-18	0.0009	0.0015
0.3750-16	0.0009	0.0016
0.4375-14	0.0010	0.0018
0.5000-13	0.0011	0.0018
0.5625-12	0.0012	0.0020
0.6250-11	0.0012	0.0021
0.7500-10	0.0013	0.0022
0.8750- 9	0.0014	0.0024
1.0000- 8	0.0016	0.0027
1.1250- 7	0.0017	0.0030
1.2500- 7	0.0017	0.0030
1.3750- 6	0.0020	0.0036
1.5000- 6	0.0020	0.0036

GENERAL NOTE:
The equivalent change in functional diameter applies to total effect of form errors. (See para. 10.4.2.) Maximum allowable variation in lead is permitted only when all other form variations are zero. For sizes not tabulated, maximum allowable variation in lead is equal to 0.57735 times one-half the pitch diameter tolerance.

TABLE 10 MAXIMUM ALLOWABLE VARIATION IN 30 deg. BASIC HALF-ANGLE OF EXTERNAL AND INTERNAL SCREW THREADS
(See Paras. 11.1.2, 11.1.3, 11.1.4, and 11.2.2 for Application)

TPI	Allowable Variation in Half-Angle of Thread (Plus or Minus), deg. and min
32	1 30
28	1 20
27	1 20
24	1 15
20	1 10
18	1 05
16	1 00
14	0 55
13	0 55
12	0 50
11½	0 50
11	0 50
10	0 50
9	0 50
8	0 45
7	0 45
6	0 40
5	0 40
4½	0 40
4	0 40

10.8 Lubrication

10.8.1 Ferrous Material. For driving in ferrous material, an appropriate lubricant must be used particularly in the hole (and it may also be applied to the male members). A noncarbonized type of lubricant (such as a rubber-in-water dispersion) is suggested. Some other lubricants are petrolatum with graphite, molybdenum disulfide, isopropyl alcohol with graphite, and white lead in oil. In applying it to the hole, care must be taken so that an excess amount of lubricant will not cause the male member to be impeded by hydraulic pressure in a blind hole.

10.8.2 Nonferrous Material. When Class 5 threaded products are driven in nonferrous material, lubrication may not be needed. The use of medium gear oil for driving in aluminum is recommended. American research has observed that the minor diameter of lubricated tapped holes in nonferrous materials may tend to close in, i.e., be reduced in driving, whereas with an unlubricated hole the minor diameter may tend to open up in some cases.

10.8.3 Sealant. Where sealing is involved, a lubricant should be selected which is insoluble in the medium being sealed.

10.9 Driving Speed

This Standard makes no recommendation for driving speed. Some opinion has been advanced that careful selection and control of driving speed is desirable to obtain optimum results with various combinations of surface hardness and roughness. Applications may indicate what limitations should be placed on driving speeds. When excessive heat is being generated during assembly, stopping to let heat dissipate may be advisable in some applications.

10.10 Relation of Driving Torque to Length of Engagement

Torque increases as the length of engagement increases. Torque increase is proportionately more rapid as size increases.

Industrial research around 1952 showed for the higher interference conditions that the direct increase in torque per turn leveled off after the assembly was well advanced. The intense heat generated during continuous assembly by forced metal movement may be sufficient to soften the metal being displaced into the designed cavity space. Failure during assembly or even in breakaway may be the result of the assembly welding together.

10.11 Breakloose Torques

This Standard does not establish recommended breakloose torques.

11 PRODUCT SCREW THREAD ACCEPTABILITY

11.1 Gaging Systems

Screw thread gaging systems for dimensional acceptability are selected in accordance with ANSI/ASME B1.3M.

The design concept for interference-fit thread assemblies does not lend itself to control of functional diameter size only.

11.1.1 System 21. When System 21 of ANSI/ASME B1.3M is selected, product thread lead (including helix), flank angle variations, and circular runout are not considered. Where there is assembly and performance concern for uniform thickness of interference metal, cavity space, prevailing torque, and uniform stress, System 21 alone may not be acceptable, since it does not provide for minimum-material size control.

11.1.2 System 22. When System 22 of ANSI/ASME B1.3M is selected, pitch diameter or thread-groove diameter inspection is required, and the product thread lead (including helix) and flank angles shall be considered acceptable when the minimum-material size (pitch diameter or thread-groove diameter in ANSI/ASME B1.3M) and the maximum-material size (GO in ANSI/ASME B1.3M) are accepted by the gages specified for System 22, over the standard GO thread gage length.

11.1.3 System 23. When System 23 of ANSI/ASME B1.3M is selected, pitch diameter or thread-groove diameter inspection is required, and the product thread lead (including helix) and flank angles shall be considered acceptable if they are within the allowable variations, specified in Tables 9 and 10, respectively. Also, the minimum-material size (pitch diameter or thread-groove diameter in ANSI/ASME B1.3M) and maximum-material size (GO in ANSI/ASME B1.3M) must be accepted by the gages specified for System 23, over the standard GO thread gage length.

Allowable variations in lead and flank angles are maximum values. Maximum variation in each of these and pitch diameter tolerance cannot be taken simultaneously. (See paras. 10.4.2 and 11.2.2.)

11.1.4 Modified System. When individual inspections of lead (including helix) and flank angle variations are required, in addition to System 21 or 22 of ANSI/ASME B1.3M, the allowable variations for these characteristics shall be specified.

11.2 Product Thread Characteristics Conformance Requirements Over Length of Engagement for Gaging Systems 22 and 23

11.2.1 Diameter Size—Pitch Diameter, Functional Diameter Size, Major Diameter, Minor Diameter. Functional diameter size measurement verifies the maximum-material size over the gaging length. Pitch diameter size measurements at positions along and around the product thread verify the minimum-material size. Taper and roundness are included in the pitch diameter size measurements; therefore, they may not exceed the pitch diameter size limits. (See para. 10.3.2.) Major diameter and minor diameter size verifies the cavity space. Table 11 gives limits of size for working gages and Table 12 gives limits of size for setting gages. Table 5 lists constants used in preparing gage dimension.

11.2.2 Form—Lead, Flank Angle, Root Profile, Crest Profile. When specified by the gaging system, lead and flank angles are measured directly or as pitch diameter equivalents. Cumulative form restrictions in para. 10.4.2 apply. Root and crest profile are verified by optical projection or a mechanical/electrical tracer when specified.

11.2.3 Position of Axes When Assembled. The independent measurements of the various screw-thread characteristics do not ensure the required coaxial relationship of the internal and external threads at assembly. When circular runout inspection is specified, refer to para. 10.6 for tolerances.

12 TORQUE

The maximum and minimum torque values were established by the National Screw Thread Commission in 1925 from data submitted from many companies. They plotted the volume of interference material per turn against the tangential force at the thread surface and developed a parabolic equation.

$$F^2 = 9 \times 10^8 \, V \text{ for maximum torque}$$

where

V = volume of interference material per turn, in.^{3}
F = tangential forces per turn at thread surface, lb

TABLE 11 WORKING GAGES[1]

Nominal Size and Designation	Gages for External Threads						Nominal Size and Designation	Gages for Internal Threads					
	X Thread Gages				Z Plain Gages for Major Diam.			X Thread Gages				Z Plain Gages for Minor Diam.	
	Max. Material		Min. Material					Max. Material		Min. Material			
	Pitch Diam.	Minor Diam.	Pitch Diam.	Minor Diam.	Max. Matl.	Min. Matl.		Major Diam.	Pitch Diam.	Major Diam.	Pitch Diam.	Max. Matl.	Min. Matl.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1/4-20 NC-5 HF,	0.2230	0.2014	0.2204	0.2096	0.2470	0.2418	1/4-20 NC-5 IF,	0.2500	0.2175	0.2418	0.2201	0.1960	0.2060
NC-5 CSF,	0.2227	0.2009	0.2207	0.2101	0.2469	0.2419	NC-5 INF	0.2505	0.2178	0.2413	0.2198	0.1961	0.2059
NC-5 ONF													
5/16-18 NC-5 HF	0.2829	0.2588	0.2799	0.2679	0.3080	0.3020	5/16-18 NC-5 IF,	0.3125	0.2764	0.3035	0.2794	0.2520	0.2630
	0.2826	0.2583	0.2802	0.2684	0.3079	0.3021	NC-5 INF	0.3130	0.2767	0.3030	0.2791	0.2521	0.2629
5/16-18 NC-5 CSF,	0.2829	0.2588	0.2799	0.2679	0.3090	0.3030							
NC-5 ONF	0.2826	0.2583	0.2802	0.2684	0.3089	0.3031							
3/8-16 NC-5 HF	0.3414	0.3143	0.3382	0.3247	0.3690	0.3626	3/8-16 NC-5 IF,	0.3750	0.3344	0.3647	0.3376	0.3070	0.3180
	0.3411	0.3137	0.3385	0.3253	0.3689	0.3627	NC-5 INF	0.3756	0.3347	0.3641	0.3373	0.3071	0.3179
3/8-16 NC-5 CSF,	0.3414	0.3143	0.3382	0.3247	0.3710	0.3646							
NC-5 ONF	0.3411	0.3137	0.3385	0.3253	0.3709	0.3647							
7/16-14 NC-5 HF	0.3991	0.3682	0.3955	0.3800	0.4305	0.4233	7/16-14 NC-5 IF	0.4375	0.3911	0.4256	0.3947	0.3740	0.3810
	0.3988	0.3676	0.3958	0.3806	0.4304	0.4234		0.4381	0.3914	0.4250	0.3944	0.3741	0.3809
7/16-14 NC-5 CSF,	0.3991	0.3682	0.3955	0.3800	0.4330	0.4258	7/16-14 NC-5 INF	0.4375	0.3911	0.4256	0.3947	0.3600	0.3720
NC-5 ONF	0.3988	0.3676	0.3958	0.3806	0.4329	0.4259		0.4381	0.3914	0.4250	0.3944	0.3601	0.3719
1/2-13 NC-5 HF	0.4584	0.4251	0.4547	0.4380	0.4920	0.4846	1/2-13 NC-5 IF	0.5000	0.4500	0.4870	0.4537	0.4310	0.4400
	0.4581	0.4245	0.4550	0.4386	0.4919	0.4847		0.5006	0.4503	0.4864	0.4534	0.4311	0.4399
1/2-13 NC-5 CSF,	0.4584	0.4251	0.4547	0.4380	0.4950	0.4876	1/2-13 NC-5 INF	0.5000	0.4500	0.4870	0.4537	0.4170	0.4290
NC-5 ONF	0.4581	0.4245	0.4550	0.4386	0.4949	0.4877		0.5006	0.4503	0.4864	0.4534	0.4171	0.4289
9/16-12 NC-5 HF	0.5176	0.4815	0.5136	0.4956	0.5540	0.5460	9/16-12 NC-5 IF	0.5625	0.5084	0.5485	0.5124	0.4880	0.4970
	0.5173	0.4809	0.5139	0.4962	0.5539	0.5461		0.5631	0.5087	0.5479	0.5121	0.4881	0.4969
9/16-12 NC-5 CSF,	0.5176	0.4815	0.5136	0.4956	0.5575	0.5495	9/16-12 NC-5 INF	0.5625	0.5084	0.5485	0.5124	0.4720	0.4850
NC-5 ONF	0.5173	0.4809	0.5139	0.4962	0.5574	0.5496		0.5631	0.5087	0.5479	0.5121	0.4721	0.4849

TABLE 11 WORKING GAGES[1] (CONT'D)

	Gages for External Threads							Gages for Internal Threads					
	X Thread Gages				Z Plain Gages for Major Diam.			X Thread Gages				Z Plain Gages for Minor Diam.	
	Max. Material		Min. Material					Max. Material		Min. Material			
Nominal Size and Designation	Pitch Diam.	Minor Diam.	Pitch Diam.	Minor Diam.	Max. Matl.	Min. Matl.	Nominal Size and Designation	Major Diam.	Pitch Diam.	Major Diam.	Pitch Diam.	Max. Matl.	Min. Matl.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
5/8-11 NC-5 HF	0.5758	0.5364	0.5716	0.5519	0.6140	0.6056	5/8-11 NC-5 IF	0.6250	0.5660	0.6096	0.5702	0.5440	0.5540
	0.5755	0.5358	0.5719	0.5525	0.6139	0.6057		0.6256	0.5663	0.6090	0.5699	0.5441	0.5539
5/8-11 NC-5 CSF,	0.5758	0.5364	0.5716	0.5519	0.6195	0.6111	5/8-11 NC-5 INF	0.6250	0.5660	0.6096	0.5702	0.5270	0.5400
NC-5 ONF	0.5755	0.5358	0.5719	0.5525	0.6194	0.6112		0.6256	0.5663	0.6090	0.5699	0.5271	0.5399
3/4-10 NC-5 HF	0.6955	0.6522	0.6910	0.6694	0.7360	0.7270	3/4-10 NC-5 IF	0.7500	0.6850	0.7328	0.6895	0.6610	0.6780
	0.6952	0.6516	0.6913	0.6700	0.7359	0.7271		0.7506	0.6853	0.7322	0.6892	0.6611	0.6779
3/4-10 NC-5 CSF,	0.6955	0.6522	0.6910	0.6694	0.7440	0.7350	3/4-10 NC-5 INF	0.7500	0.6850	0.7328	0.6895	0.6420	0.6550
NC-5 ONF	0.6952	0.6516	0.6913	0.6700	0.7439	0.7351		0.7506	0.6853	0.7322	0.6892	0.6421	0.6549
7/8- 9 NC-5 HF	0.8144	0.7663	0.8095	0.7854	0.8600	0.8502	7/8- 9 NC-5 IF	0.8750	0.8028	0.8558	0.8077	0.7770	0.7890
	0.8141	0.7656	0.8098	0.7861	0.8599	0.8503		0.8757	0.8031	0.8551	0.8074	0.7771	0.7889
7/8- 9 NC-5 CSF,	0.8144	0.7663	0.8095	0.7854	0.8685	0.8587	7/8- 9 NC-5 INF	0.8750	0.8028	0.8558	0.8077	0.7550	0.7690
NC-5 ONF	0.8141	0.7656	0.8098	0.7861	0.8684	0.8588		0.8757	0.8031	0.8551	0.8074	0.7551	0.7689
1 - 8 NC-5 HF	0.9316	0.8775	0.9262	0.8991	0.9835	0.9727	1 - 8 NC-5 IF	1.0000	0.9188	0.9783	0.9242	0.8900	0.9040
	0.9312	0.8768	0.9266	0.8998	0.9834	0.9728		1.0007	0.9192	0.9776	0.9238	0.8901	0.9039
1 - 8 NC-5 CSF,	0.9316	0.8775	0.9262	0.8991	0.9935	0.9827	1 - 8 NC-5 INF	1.0000	0.9188	0.9783	0.9242	0.8650	0.8800
NC-5 ONF	0.9312	0.8768	0.9266	0.8998	0.9934	0.9828		1.0007	0.9192	0.9776	0.9238	0.8651	0.8799
1 1/8- 7 NC-5 HF	1.0465	0.9846	1.0406	1.0097	1.1070	1.0952	1 1/8- 7 NC-5 IF	1.1250	1.0322	1.1000	1.0381	1.0000	1.0150
	1.0461	0.9839	1.0410	1.0104	1.1069	1.0953		1.1257	1.0326	1.0993	1.0377	1.0001	1.0149
1 1/8- 7 NC-5 CSF,	1.0465	0.9846	1.0406	1.0097	1.1180	1.1062	1 1/8- 7 NC-5 INF	1.1250	1.0322	1.1000	1.0381	0.9700	0.9860
NC-5 ONF	1.0461	0.9839	1.0410	1.0104	1.1179	1.1063		1.1257	1.0326	1.0993	1.0377	0.9701	0.9859
1 1/4- 7 NC-5 HF	1.1715	1.1096	1.1656	1.1347	1.2320	1.2200	1 1/4- 7 NC-5 IF	1.2500	1.1572	1.2250	1.1631	1.1250	1.1400
	1.1711	1.1089	1.1660	1.1354	1.2319	1.2201		1.2507	1.1576	1.2243	1.1627	1.1251	1.1399
1 1/4- 7 NC-5 CSF,	1.1715	1.1096	1.1656	1.1347	1.2430	1.2312	1 1/4- 7 NC-5 INF	1.2500	1.1572	1.2250	1.1631	1.0950	1.1110
NC-5 ONF	1.1711	1.1089	1.1660	1.1354	1.2429	1.2313		1.2507	1.1576	1.2243	1.1627	1.0951	1.1109

TABLE 11 WORKING GAGES[1] (CONT'D)

Nominal Size and Designation	Gages for External Threads: X Thread Gages: Max. Material: Pitch Diam.	Gages for External Threads: X Thread Gages: Max. Material: Minor Diam.	Gages for External Threads: X Thread Gages: Min. Material: Pitch Diam.	Gages for External Threads: X Thread Gages: Min. Material: Minor Diam.	Gages for External Threads: Z Plain Gages for Major Diam.: Max. Matl.	Gages for External Threads: Z Plain Gages for Major Diam.: Min. Matl.	Nominal Size and Designation	Gages for Internal Threads: X Thread Gages: Max. Material: Major Diam.	Gages for Internal Threads: X Thread Gages: Max. Material: Pitch Diam.	Gages for Internal Threads: X Thread Gages: Min. Material: Major Diam.	Gages for Internal Threads: X Thread Gages: Min. Material: Pitch Diam.	Gages for Internal Threads: Z Plain Gages for Minor Diam.: Max. Matl.	Gages for Internal Threads: Z Plain Gages for Minor Diam.: Min. Matl.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1⅜- 6 NC-5 HF	1.2839	1.2117	1.2768	1.2407	1.3560	1.3410	1⅜- 6 NC-5 IF	1.3750	1.2667	1.3460	1.2738	1.2290	1.2470
	1.2835	1.2109	1.2772	1.2415	1.3559	1.3411		1.3758	1.2671	1.3452	1.2734	1.2291	1.2469
1⅜- 6 NC-5 CSF,	1.2839	1.2117	1.2768	1.2407	1.3680	1.3538	1⅜- 6 NC-5 INF	1.3750	1.2667	1.3460	1.2738	1.1950	1.2130
NC-5 ONF	1.2835	1.2109	1.2772	1.2415	1.3679	1.3539		1.3758	1.2671	1.3452	1.2734	1.1951	1.2129
1½- 6 NC-5 HF	1.4089	1.3367	1.4018	1.3657	1.4810	1.4670	1½- 6 NC-5 IF	1.5000	1.3917	1.4710	1.3988	1.3540	1.3720
	1.4085	1.3359	1.4022	1.3665	1.4809	1.4671		1.5008	1.3921	1.4702	1.3984	1.3541	1.3719
1½- 6 NC-5 CSF,	1.4089	1.3367	1.4018	1.3657	1.4930	1.4788	1½- 6 NC-5 INF	1.5000	1.3917	1.4710	1.3988	1.3200	1.3380
NC-5 ONF	1.4085	1.3359	1.4022	1.3665	1.4929	1.4789		1.5008	1.3921	1.4702	1.3984	1.3201	1.3379

NOTE:
(1) For HF, CSF, and ONF, and for IF and INF, the respective thread gages are the same. The plain gages are not interchangeable.

TABLE 12 SETTING GAGES

Nominal Size	W Thread-Setting Plugs						W Thread-Setting Rings			
	Max. Material			Min. Material			Max. Material		Min. Material	
	Major Diameter			Major Diameter						
	Truncated [Note (1)]	Full Form [Note (2)]	Pitch Diam. [Note (3)]	Truncated [Note (4)]	Full Form [Note (2)]	Pitch Diam. [Note (3)]	Pitch Diam. [Note (3)]	Minor Diam. [Note (5)]	Pitch Diam. [Note (3)]	Minor Diam. [Note (6)]
1	2	3	4	5	6	7	8	9	10	11
1/4-20 NC-5	0.2380 0.2375	0.2470 0.2475	0.2230 0.2229	0.2362 0.2357	0.2470 0.2475	0.2204 0.2205	0.2175 0.2176	0.1960 0.1955	0.2201 0.2200	0.2060 0.2055
5/16-18 NC-5	0.2993 0.2988	0.3090 0.3095	0.2829 0.2828	0.2970 0.2965	0.3090 0.3095	0.2700 0.2800	0.2764 0.2765	0.2520 0.2515	0.2794 0.2793	0.2630 0.2625
3/8-16 NC-5	0.3605 0.3599	0.3710 0.3716	0.3414 0.3413	0.3575 0.3569	0.3710 0.3716	0.3382 0.3383	0.3344 0.3345	0.3070 0.3064	0.3376 0.3375	0.3180 0.3174
7/16-14 NC-5	0.4215 0.4209	0.4330 0.4336	0.3991 0.3990	0.4175 0.4169	0.4330 0.4336	0.3955 0.3956	0.3911 0.3912	0.3600 0.3594	0.3947 0.3946	0.3720 0.3714
1/2-13 NC-5	0.4828 0.4822	0.4950 0.4956	0.4584 0.4582	0.4783 0.4777	0.4950 0.4956	0.4547 0.4548	0.4500 0.4502	0.4170 0.4164	0.4537 0.4536	0.4290 0.4284
9/16-12 NC-5	0.5446 0.5440	0.5575 0.5581	0.5176 0.5174	0.5395 0.5389	0.5575 0.5581	0.5136 0.5138	0.5084 0.5086	0.4720 0.4714	0.5124 0.5122	0.4850 0.4844
5/8-11 NC-5	0.6058 0.6052	0.6195 0.6201	0.5758 0.5756	0.5998 0.5992	0.6195 0.6201	0.5716 0.5718	0.5660 0.5662	0.5270 0.5264	0.5702 0.5700	0.5400 0.5394
3/4-10 NC-5	0.7294 0.7288	0.7440 0.7446	0.6955 0.6953	0.7223 0.7217	0.7440 0.7446	0.6910 0.6912	0.6850 0.6852	0.6420 0.6414	0.6895 0.6893	0.6550 0.6544
7/8- 9 NC-5	0.8527 0.8520	0.8685 0.8692	0.8144 0.8142	0.8444 0.8437	0.8685 0.8692	0.8095 0.8097	0.8028 0.8030	0.7550 0.7543	0.8077 0.8075	0.7690 0.7683
1 - 8 NC-5	0.9764 0.9757	0.9935 0.9942	0.9316 0.9314	0.9664 0.9657	0.9935 0.9942	0.9262 0.9264	0.9188 0.9190	0.8650 0.8643	0.9242 0.9240	0.8800 0.8793
1 1/8- 7 NC-5	1.0764 1.0757	1.1180 1.1187	1.0465 1.0463	1.0871 1.0854	1.1180 1.1187	1.0406 1.0408	1.0322 1.0324	0.9700 0.9693	1.0381 1.0379	0.9860 0.9853
1 1/4- 7 NC-5	1.2242 1.2235	1.2430 1.2437	1.1715 1.1713	1.2121 1.2114	1.2430 1.2437	1.1656 1.1658	1.1572 1.1574	1.0950 1.0943	1.1631 1.1629	1.1110 1.1103

TABLE 12 SETTING GAGES (CONT'D)

	W Thread-Setting Plugs						W Thread-Setting Rings			
	Max. Material			Min. Material			Max. Material		Min. Material	
	Major Diameter			Major Diameter						
Nominal Size	Truncated [Note (1)]	Full Form [Note (2)]	Pitch Diam. [Note (3)]	Truncated [Note (4)]	Full Form [Note (2)]	Pitch Diam. [Note (3)]	Pitch Diam. [Note (3)]	Minor Diam. [Note (5)]	Pitch Diam. [Note (3)]	Minor Diam. [Note (6)]
1	2	3	4	5	6	7	8	9	10	11
1⅜- 6 NC-5	1.3470 1.3462	1.3680 1.3688	1.2839 1.2837	1.3319 1.3311	1.3680 1.3688	1.2768 1.2770	1.2667 1.2669	1.1950 1.1942	1.2738 1.2736	1.2130 1.2122
1½- 6 NC-5	1.4720 1.4712	1.4930 1.4938	1.4089 1.4087	1.4569 1.4561	1.4930 1.4938	1.4018 1.4020	1.3917 1.3919	1.3200 1.3192	1.3988 1.3986	1.3380 1.3372

NOTES:
(1) Maximum-material truncated major diameter equals maximum major diameter of external thread series NC-5 CSF minus $(0.06\sqrt[3]{p^2} + 0.017p)$, W tolerance minus.
(2) Full-form major diameter equals maximum major diameter of external thread series NC-5 CSF, W tolerance plus.
(3) Pitch diameter tolerances greater than W are acceptable for setting indicating gages only when the indicating gage is set to the calibrated pitch diameter.
(4) Minimum-material truncated major diameter equals maximum major diameter of external thread series NC-5 CSF minus $0.25H$, W tolerance minus.
(5) Maximum-material minor diameter equals minimum minor diameter of internal thread series NC-5 INF, W tolerance minus.
(6) Minimum-material minor diameter equals maximum minor diameter of internal thread series NC-5 INF, W tolerance minus.

APPENDIX A
Obsolete Tentative Standard and Alternate Standard for Class 5 Interference-Fit Thread (Not to Be Used for New Design)

(This Appendix is not part of ASME/ANSI B1.12-1987, and is included for information purposes only.)

A1 INTRODUCTION

Appendix A contains useful information that is supplementary to this Standard.

Since Class 5 interference-fit threads based on both the obsolete Tentative Standard and the obsolete Alternate Standard are still in use today on spare parts in stock and appear on many drawings, the following profiles and tables on limits of size and gages are reproduced. The data is for hardened steel studs set in hard materials, i.e., cast iron, steel, and bronze.

NOTE: In comparison to the Tentative Standard, the Alternate Standard provided increased tolerances on hole threads and reduced tolerances on stud threads. Therefore, studs produced to the Tentative Standard must be installed only in holes produced to the Tentative Standard and those produced to the Alternate Standard installed only in holes produced to the Alternate Standard.

Percentages of interference metal per turn of engagement, compared to NC-5 HF/IF at 100%, are given in Table D1 for the Tentative and Alternate Standards.

A2 TENTATIVE STANDARD

Tentative American National Standard Class 5 Interference Fit Threads was published by the National Screw Thread Commission in 1928 and 1933 and by the National Bureau of Standards in Handbooks H25-1939, H28-1942, and H28-1950.

A2.1 Size Limits and Thread Profiles

Tables A1, A2, A3, and A4 give the tolerances, allowances, and limits of size for both coarse and fine thread series. Figures A1, A2, and A3 show thread profiles.

A2.2 Acceptability

Product thread acceptability shall be in accordance with ANSI/ASME B1.3M based upon the method specified. Gages shall be designed in accordance with the principles in ANSI/ASME B1.2.

A3 ALTERNATE STANDARD

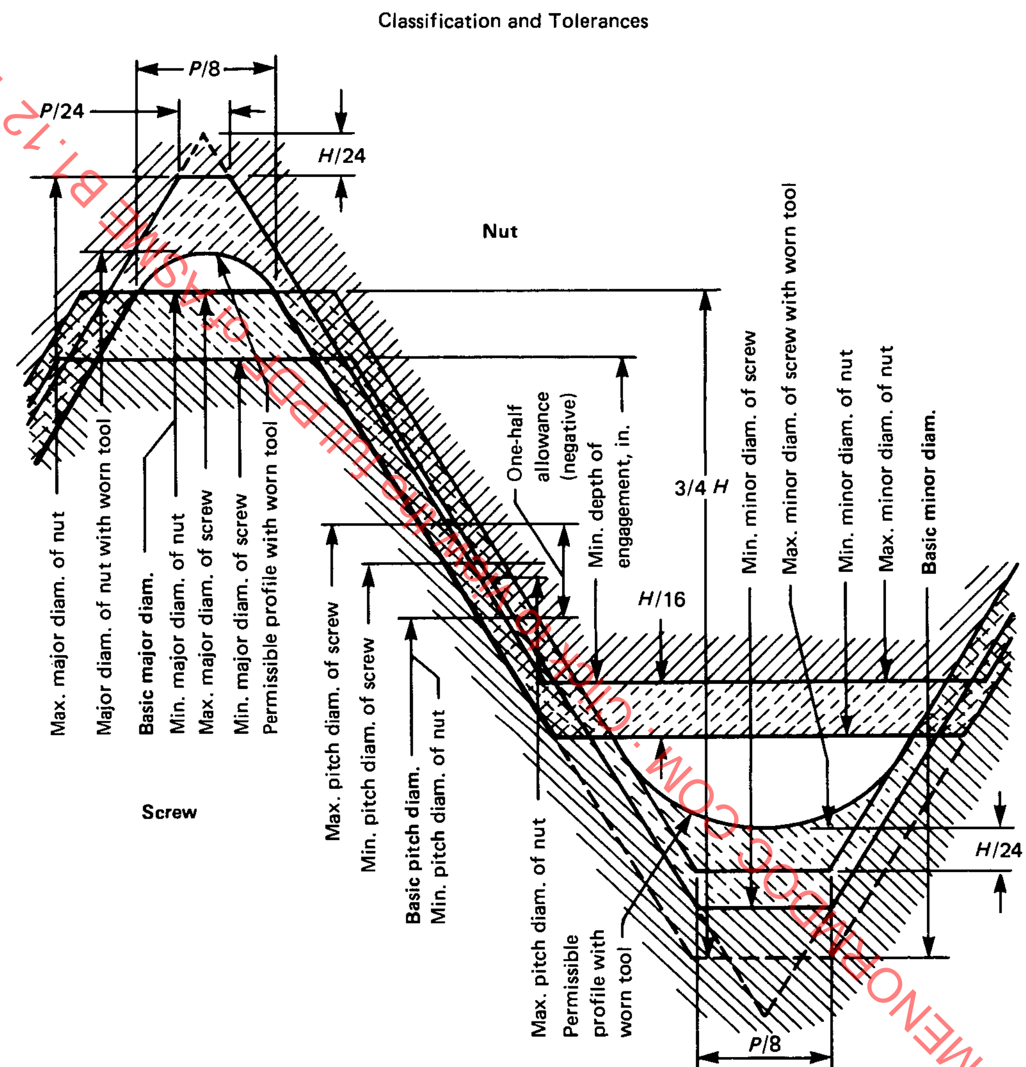
The Alternate Standard, American National Class 5 Interference Fit Threads, was published by the National Bureau of Standards in Handbooks H28-1942 and H28-1944.

A3.1 Size Limits and Thread Profiles

Tables A5, A6, A7, and A8 give the tolerances, allowances, and limits of size for both coarse and fine thread series. Figures A1, A4, and A5 show thread profiles.

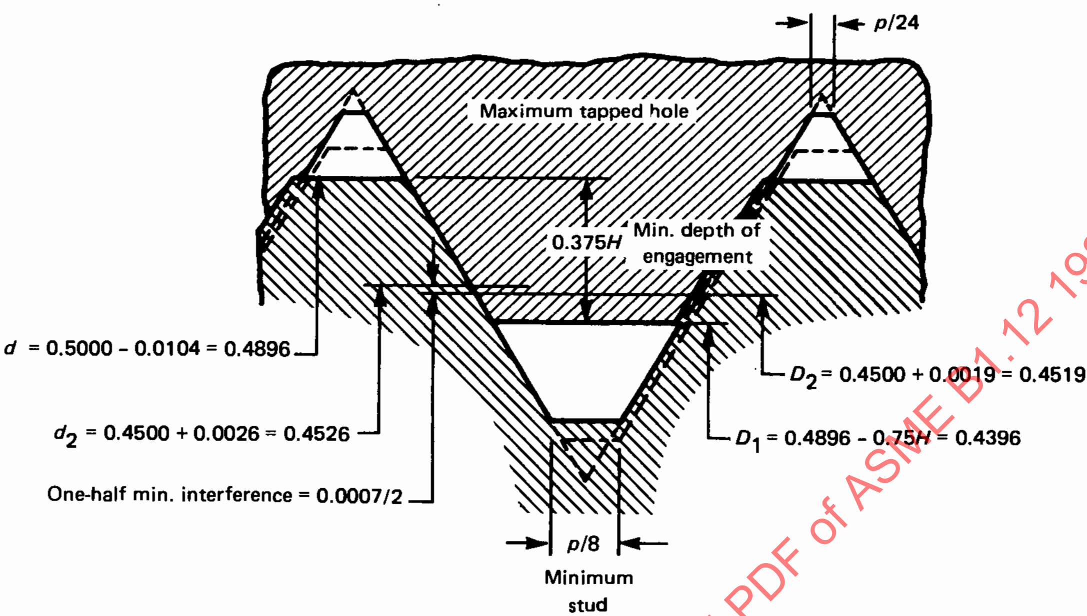
A3.2 Acceptability

Product thread acceptability shall be in accordance with ANSI/ASME B1.3M based upon the method specified. Gages are in accordance with ANSI/ASME B1.2, except Tables A9, A10, A11, and A12 give the limits of size for all gages.



GENERAL NOTE: Heavy line shows basic size.

FIG. A1 ILLUSTRATION OF TOLERANCES, ALLOWANCES, AND CREST CLEARANCES FOR TENTATIVE AND ALTERNATE CLASS 5 FIT FOR THREADED STUDS



GENERAL NOTE: Broken line shows basic size.

FIG. A2 ILLUSTRATION OF LOOSEST CONDITION FOR TENTATIVE CLASS 5 WRENCH FIT FOR THREADED STUDS, ½ in., 13 THREADS, SET IN HARD MATERIALS

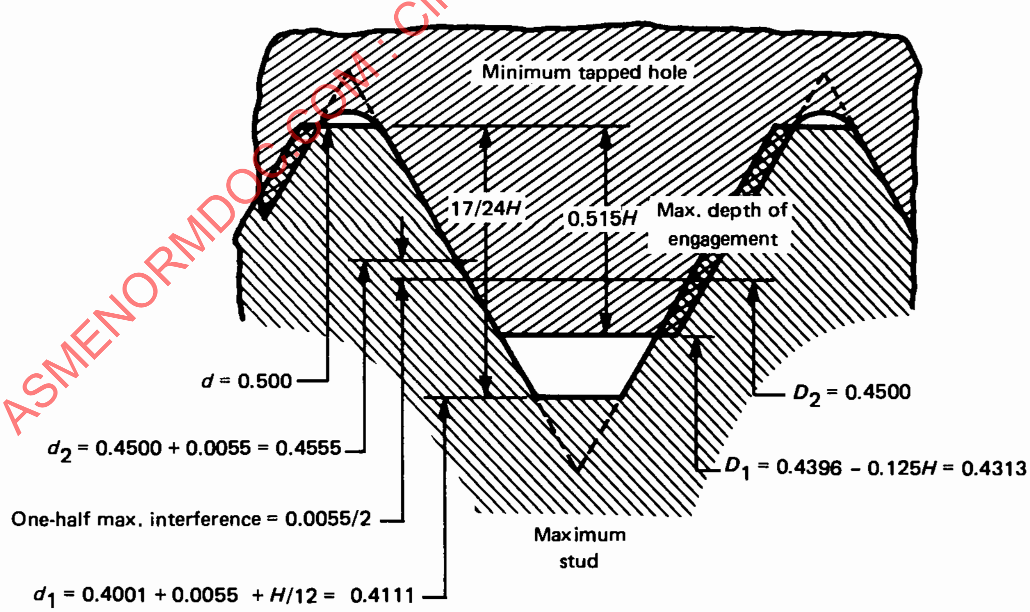


FIG. A3 ILLUSTRATION OF TIGHTEST CONDITION FOR TENTATIVE CLASS 5 WRENCH FIT FOR THREADED STUDS, ½ in., 13 THREADS, SET IN HARD MATERIALS

TENTATIVE STANDARD

TABLE A1 TENTATIVE CLASS 5 WRENCH FIT FOR THREADED STUDS, ALLOWANCES AND TOLERANCES FOR STUDS AND TAPPED HOLES, COARSE THREADED STUDS SET IN HARD MATERIALS

Nominal Size	Threads per inch	Interference on Pitch Diameter, in.		Pitch Diameter Tolerances, in.		Errors in Half-Angle Consuming One-Half of Pitch Diameter Tolerances, deg. and min			
		Minimum	Maximum	Stud	Tapped Hole	Stud		Tapped Hole	
1	2	3	4	5	6	7		8	
1/4	20	0.0003	0.0018	0.0007	0.0008	0	16	0	25
5/16	18	0.0005	0.0040	0.0020	0.0015	0	41	0	31
3/8	16	0.0005	0.0045	0.0024	0.0016	0	44	0	29
7/16	14	0.0006	0.0050	0.0026	0.0018	0	42	0	29
1/2	13	0.0007	0.0055	0.0029	0.0019	0	44	0	28
9/16	12	0.0008	0.0060	0.0032	0.0020	0	44	0	28
5/8	11	0.0008	0.0060	0.0031	0.0021	0	39	0	26
3/4	10	0.0009	0.0065	0.0033	0.0023	0	38	0	26
7/8	9	0.0010	0.0065	0.0031	0.0024	0	32	0	25
1	8	0.0011	0.0065	0.0027	0.0027	0	25	0	25
1 1/8	7	0.0011	0.0065	0.0024	0.0030	0	19	0	24
1 1/4	7	0.0012	0.0065	0.0023	0.0030	0	18	0	24
1 3/8	6	0.0012	0.0065	0.0017	0.0036	0	12	0	25
1 1/2	6	0.0013	0.0070	0.0021	0.0036	0	14	0	25

TABLE A2 TENTATIVE CLASS 5 WRENCH FIT FOR THREADED STUDS, ALLOWANCES AND TOLERANCES FOR STUDS AND TAPPED HOLES, FINE THREADED STUDS SET IN HARD MATERIALS

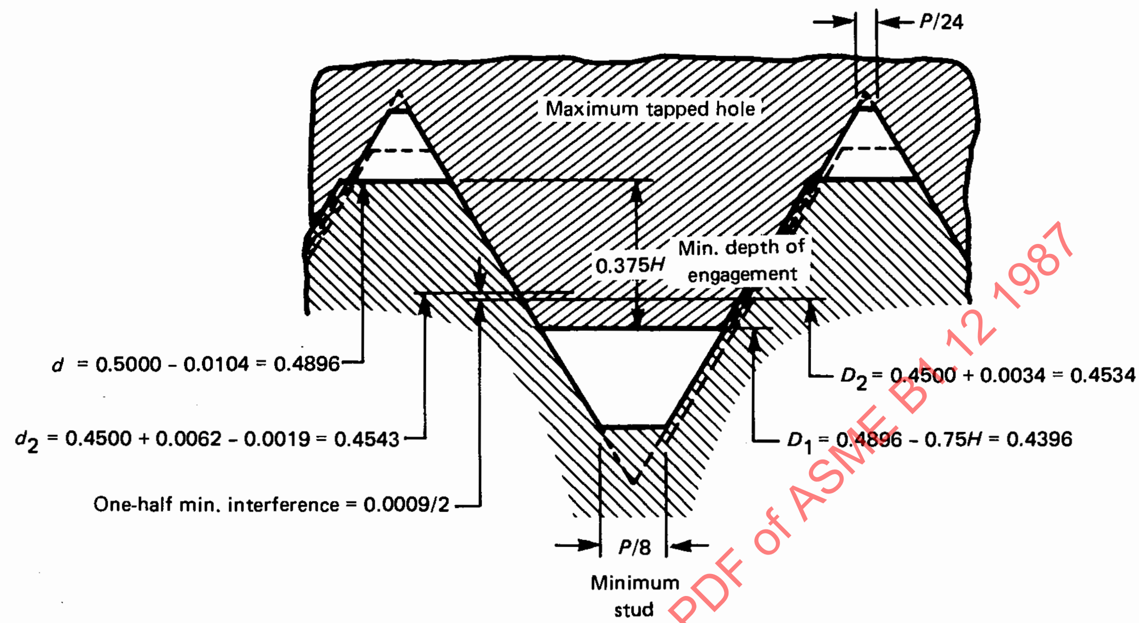
Nominal Size	Threads per inch	Interference on Pitch Diameter, in.		Pitch Diameter Tolerances, in.		Errors in Half-Angle Consuming One-Half of Pitch Diameter Tolerances, deg. and min			
		Minimum	Maximum	Stud	Tapped Hole	Stud		Tapped Hole	
1	2	3	4	5	6	7		8	
1/4	28	0.0005	0.0034	0.0018	0.0011	0	58	0	35
5/16	24	0.0005	0.0037	0.0020	0.0012	0	55	0	33
3/8	24	0.0006	0.0044	0.0026	0.0012	1	11	0	33
7/16	20	0.0006	0.0044	0.0025	0.0013	0	57	0	30
1/2	20	0.0007	0.0050	0.0030	0.0013	1	9	0	30
9/16	18	0.0007	0.0050	0.0028	0.0015	0	58	0	31
5/8	18	0.0008	0.0055	0.0032	0.0015	1	6	0	31
3/4	16	0.0008	0.0059	0.0035	0.0016	1	4	0	29
7/8	14	0.0008	0.0061	0.0035	0.0018	0	56	0	29
1	14	0.0009	0.0069	0.0042	0.0018	1	7	0	29
1 1/8	12	0.0009	0.0067	0.0038	0.0020	0	52	0	28
1 1/4	12	0.0011	0.0060	0.0029	0.0020	0	40	0	28
1 3/8	12	0.0011	0.0055	0.0024	0.0020	0	33	0	28
1 1/2	12	0.0012	0.0050	0.0018	0.0020	0	25	0	28

TABLE A3 LIMITING DIMENSIONS FOR TENTATIVE CLASS 5 WRENCH FIT FOR AMERICAN NATIONAL COARSE THREAD SERIES, STEEL STUDS SET IN HARD MATERIALS (CAST IRON, SEMISTEEL, BRONZE, ETC.)

		Stud Sizes					Tapped Hole Sizes								
		Major Diameter, in.		Pitch Diameter, in.		*Minor* Diam., in.	Minor Diameter, in.		Pitch Diameter, in.		Major Diam., in.	Recommended Tap Drill Size		Approximate Torque at Full Engagement of 1½ *D*, lb–in.	
Nominal Size	Threads per inch	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Nominal Size	Diam., in.	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1/4	20	0.2500	0.2428	0.2193	0.2186	0.1904	0.2049	0.2103	0.2175	0.2183	0.2500	No. 4	0.2090	105	35
5/16	18	0.3125	0.3043	0.2804	0.2784	0.2483	0.2622	0.2682	0.2764	0.2779	0.3125	H	0.2660	265	80
3/8	16	0.3750	0.3660	0.3389	0.3365	0.3028	0.3186	0.3254	0.3344	0.3360	0.3750	P	0.3230	420	120
7/16	14	0.4375	0.4277	0.3961	0.3935	0.3549	0.3736	0.3813	0.3911	0.3929	0.4375	V	0.3770	610	180
1/2	13	0.5000	0.4896	0.4555	0.4526	0.4111	0.4313	0.4396	0.4500	0.4519	0.5000	7/16	0.4375	850	265
9/16	12	0.5625	0.5513	0.5144	0.5112	0.4663	0.4882	0.4972	0.5084	0.5104	0.5625	12.5 mm	0.4921	1,170	360
5/8	11	0.6250	0.6132	0.5720	0.5689	0.5195	0.5444	0.5542	0.5660	0.5681	0.6250	35/64	0.5469	1,450	450
3/4	10	0.7500	0.7372	0.6915	0.6882	0.6338	0.6614	0.6722	0.6850	0.6873	0.7500	43/64	0.6719	2,300	730
7/8	9	0.8750	0.8610	0.8093	0.8062	0.7452	0.7768	0.7888	0.8028	0.8052	0.8750	25/32	0.7812	3,200	1,080
1	8	1.0000	0.9848	0.9253	0.9226	0.8531	0.8901	0.9036	0.9188	0.9215	1.0000	57/64	0.8906	4,250	1,500
1 1/8	7	1.1250	1.1080	1.0387	1.0363	0.9562	0.9998	1.0152	1.0322	1.0352	1.1250	1	1.0000	5,300	1,875
1 1/4	7	1.2500	1.2330	1.1637	1.1614	1.0812	1.1248	1.1402	1.1572	1.1602	1.2500	1 1/8	1.1250	6,950	2,535
1 3/8	6	1.3750	1.3548	1.2732	1.2715	1.1770	1.2286	1.2466	1.2667	1.2703	1.3750	1 15/64	1.2344	8,150	2,970
1 1/2	6	1.5000	1.4798	1.3987	1.3966	1.3025	1.3536	1.3716	1.3917	1.3953	1.5000	1 23/64	1.3594	10,400	3,900

TABLE A4 LIMITING DIMENSIONS FOR TENTATIVE CLASS 5 WRENCH FIT FOR AMERICAN NATIONAL FINE THREAD SERIES, STEEL STUDS SET IN HARD MATERIALS (CAST IRON, SEMISTEEL, BRONZE, ETC.)

		Stud Sizes					Tapped Hole Sizes								
		Major Diameter, in.		Pitch Diameter, in.		Minor Diam., in.	Minor Diameter, in.		Pitch Diameter, in.		Major Diam., in.	Recommended Tap Drill Size		Approximate Torque at Full Engagement of 1½ *D*, lb-in.	
Nominal Size	Threads per inch	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Nominal Size	Diam., in.	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1/4	28	0.2500	0.2438	0.2302	0.2284	0.2096	0.2167	0.2206	0.2268	0.2279	0.2500	7/32	0.2188	140	45
5/16	24	0.3125	0.3059	0.2891	0.2871	0.2650	0.2743	0.2788	0.2854	0.2866	0.3125	J	0.2770	230	70
3/8	24	0.3750	0.3684	0.3523	0.3497	0.3282	0.3368	0.3413	0.3479	0.3491	0.3750	R	0.3390	410	125
7/16	20	0.4375	0.4303	0.4094	0.4069	0.3805	0.3924	0.3978	0.4050	0.4063	0.4375	X	0.3970	540	170
1/2	20	0.5000	0.4928	0.4725	0.4695	0.4436	0.4549	0.4603	0.4675	0.4688	0.5000	. . .	0.4576	810	260
9/16	18	0.5625	0.5543	0.5314	0.5286	0.4993	0.5122	0.5182	0.5264	0.5279	0.5625	33/64	0.5156	1,040	330
5/8	18	0.6250	0.6168	0.5944	0.5912	0.5623	0.5747	0.5807	0.5889	0.5904	0.6250	37/64	0.5781	1,430	460
3/4	16	0.7500	0.7410	0.7153	0.7118	0.6792	0.6936	0.7004	0.7094	0.7110	0.7500	. . .	0.6970	2,200	685
7/8	14	0.8750	0.8652	0.8347	0.8312	0.7935	0.8111	0.8188	0.8286	0.8304	0.8750	13/16	0.8125	3,070	945
1	14	1.0000	0.9902	0.9605	0.9563	0.9193	0.9361	0.9438	0.9536	0.9554	1.0000	15/16	0.9375	4,590	1,410
1 1/8	12	1.1250	1.1138	1.0776	1.0738	1.0295	1.0507	1.0597	1.0709	1.0729	1.1250	. . .	1.0552	5,620	1,750
1 1/4	12	1.2500	1.2388	1.2019	1.1990	1.1538	1.1757	1.1847	1.1959	1.1979	1.2500	30.0 mm	1.1811	6,960	2,530
1 3/8	12	1.3750	1.3638	1.3264	1.3240	1.2782	1.3007	1.3097	1.3209	1.3229	1.3750	. . .	1.3052	8,440	3,225
1 1/2	12	1.5000	1.4888	1.4509	1.4491	1.4028	1.4257	1.4347	1.4459	1.4479	1.5000	. . .	1.4302	10,070	4,215



GENERAL NOTE: Broken line shows basic size.

FIG. A4 ILLUSTRATION OF LOOSEST CONDITION FOR ALTERNATE CLASS 5 FIT FOR THREADED STUDS, ½ in., 13 THREADS, SET IN HARD MATERIALS

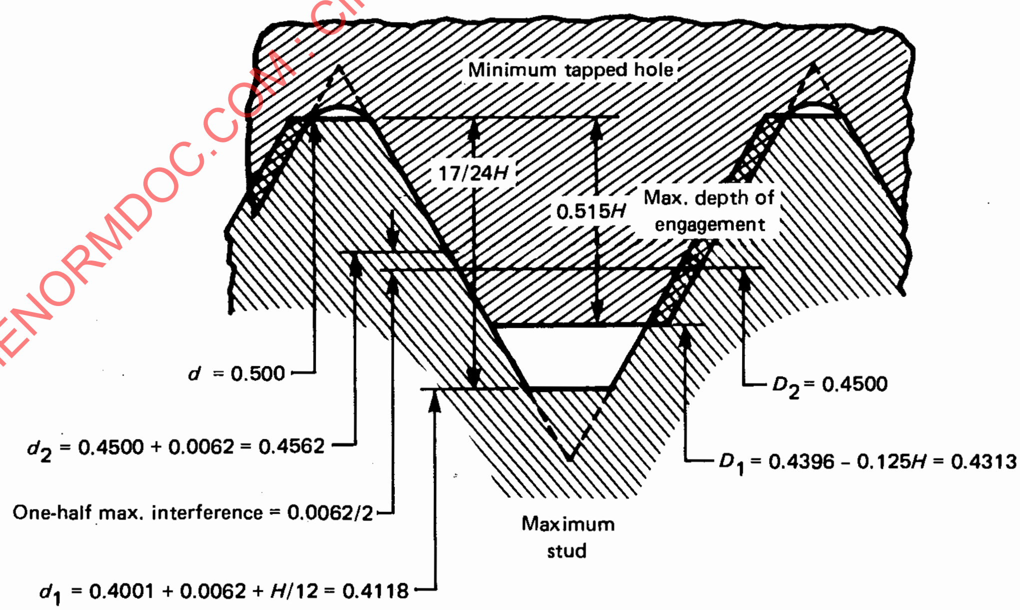


FIG. A5 ILLUSTRATION OF TIGHTEST CONDITION FOR ALTERNATE CLASS 5 FIT FOR THREADED STUDS, ½ in., 13 THREADS, SET IN HARD MATERIALS

TABLE A5 ALTERNATE CLASS 5 FIT FOR THREADED STUDS, ALLOWANCES AND TOLERANCES FOR STUDS AND TAPPED HOLES, COARSE THREADED STUDS SET IN HARD MATERIALS

Nominal Size	Threads per inch	Interference on Pitch Diameter, in.		Pitch Diameter Tolerances, in.	
		Minimum	Maximum	Stud	Tapped Hole
1	2	3	4	5	6
5/16	18	0.0005	0.0046	0.0015	0.0026
3/8	16	0.0005	0.0051	0.0016	0.0030
7/16	14	0.0007	0.0057	0.0018	0.0032
1/2	13	0.0009	0.0062	0.0019	0.0034
9/16	12	0.0011	0.0066	0.0020	0.0035
5/8	11	0.0012	0.0069	0.0021	0.0036
3/4	10	0.0013	0.0073	0.0023	0.0037
7/8	9	0.0013	0.0074	0.0024	0.0037
1	8	0.0013	0.0075	0.0025	0.0037
1 1/8	7	0.0014	0.0076	0.0025	0.0037
1 1/4	7	0.0014	0.0076	0.0025	0.0037
1 3/8	6	0.0014	0.0076	0.0025	0.0037
1 1/2	6	0.0016	0.0081	0.0025	0.0040

TABLE A6 ALTERNATE CLASS 5 FIT FOR THREADED STUDS, ALLOWANCES AND TOLERANCES FOR STUDS AND TAPPED HOLES, FINE THREADED STUDS SET IN HARD MATERIALS

Nominal Size	Threads per inch	Interference on Pitch Diameter, in.		Pitch Diameter Tolerances, in.	
		Minimum	Maximum	Stud	Tapped Hole
1	2	3	4	5	6
1/4	28	0.0006	0.0039	0.0011	0.0022
5/16	24	0.0006	0.0042	0.0012	0.0024
3/8	24	0.0008	0.0044	0.0012	0.0024
7/16	20	0.0008	0.0047	0.0013	0.0026
1/2	20	0.0011	0.0050	0.0013	0.0026
9/16	18	0.0011	0.0056	0.0015	0.0030
5/8	18	0.0011	0.0056	0.0015	0.0030
3/4	16	0.0011	0.0059	0.0016	0.0032
7/8	14	0.0011	0.0065	0.0018	0.0036
1	14	0.0015	0.0069	0.0018	0.0036
1 1/8	12	0.0015	0.0075	0.0020	0.0040
1 1/4	12	0.0015	0.0072	0.0020	0.0037
1 3/8	12	0.0015	0.0067	0.0020	0.0032
1 1/2	12	0.0015	0.0062	0.0020	0.0027

ALTERNATE STANDARD

TABLE A7 LIMITING DIMENSIONS FOR ALTERNATE CLASS 5 FIT, AMERICAN NATIONAL COARSE THREAD SERIES, STEEL STUDS SET IN HARD MATERIALS (CAST IRON, SEMISTEEL, BRONZE, ETC.)

Nominal Size	Threads per inch	Stud Sizes: Major Diameter, in.		Stud Sizes: Pitch Diameter, in.		Stud Sizes: Minor Diam., in.	Tapped Hole Sizes: Minor Diameter, in.		Tapped Hole Sizes: Pitch Diameter, in.		Tapped Hole Sizes: Major Diam., in.	Recommended Tap Drill Size, in.		Approximate Torque at Full Engagement of 1½ *D*, lb-in.	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Nominal Size	Diam.	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
5/16	18	0.3125	0.3043	0.2810	0.2795	0.2489	0.2622	0.2682	0.2764	0.2790	0.3125	0.2656	0.2656	265	80
3/8	16	0.3750	0.3660	0.3395	0.3379	0.3034	0.3186	0.3254	0.3344	0.3374	0.3750	0.3230	0.3230	420	120
7/16	14	0.4375	0.4277	0.3968	0.3950	0.3556	0.3736	0.3813	0.3911	0.3943	0.4375	0.3750	0.3750	610	195
1/2	13	0.5000	0.4896	0.4562	0.4543	0.4118	0.4313	0.4396	0.4500	0.4534	0.5000	0.4375	0.4375	850	295
9/16	12	0.5625	0.5513	0.5150	0.5130	0.4669	0.4882	0.4972	0.5084	0.5119	0.5625	12.5 mm	0.4921	1,170	425
5/8	11	0.6250	0.6132	0.5729	0.5708	0.5204	0.5444	0.5542	0.5660	0.5696	0.6250	35/64	0.5469	1,450	560
3/4	10	0.7500	0.7372	0.6923	0.6900	0.6346	0.6614	0.6722	0.6850	0.6887	0.7500	43/64	0.6719	2,300	880
7/8	9	0.8750	0.8610	0.8102	0.8078	0.7461	0.7768	0.7888	0.8028	0.8065	0.8750	25/32	0.7812	3,200	1,230
1	8	1.0000	0.9848	0.9263	0.9238	0.8541	0.8901	0.9036	0.9188	0.9225	1.0000	57/64	0.8906	4,250	1,630
1 1/8	7	1.1250	1.1080	1.0398	1.0373	0.9573	0.9998	1.0152	1.0322	1.0359	1.1250	1	1.0000	5,300	2,120
1 1/4	7	1.2500	1.2330	1.1648	1.1623	1.0823	1.1248	1.1402	1.1572	1.1609	1.2500	1 1/8	1.1250	6,950	2,780
1 3/8	6	1.3750	1.3548	1.2743	1.2718	1.1781	1.2286	1.2466	1.2667	1.2704	1.3750	1 15/64	1.2344	8,150	3,210
1 1/2	6	1.5000	1.4796	1.3998	1.3973	1.3036	1.3536	1.3716	1.3917	1.3957	1.5000	1 23/64	1.3594	10,400	4,340

TABLE A8 LIMITING DIMENSIONS FOR ALTERNATE CLASS 5 FIT, AMERICAN NATIONAL FINE THREAD SERIES, STEEL STUDS SET IN HARD MATERIALS (CAST IRON, SEMISTEEL, BRONZE, ETC.)

Nominal Size	Threads per inch	Stud Sizes					Tapped Hole Sizes					Recommended Tap Drill Size, in.		Approximate Torque at Full Engagement of 1½ *D*, lb–in.	
		Major Diameter, in.		Pitch Diameter, in.		Minor Diam., in.	Minor Diameter, in.		Pitch Diameter, in.		Major Diam., in.				
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Nominal Size	Diam.	Max.	Min.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1/4	28	0.2500	0.2436	0.2307	0.2296	0.2101	0.2167	0.2206	0.2268	0.2290	0.2500	0.2187	0.2187	140	50
5/16	24	0.3125	0.3059	0.2896	0.2884	0.2655	0.2743	0.2788	0.2854	0.2878	0.3125	0.2770	0.2770	230	80
3/8	24	0.3750	0.3684	0.3523	0.3511	0.3282	0.3368	0.3413	0.3479	0.3503	0.3750	0.3390	0.3390	410	145
7/16	20	0.4375	0.4303	0.4097	0.4084	0.3808	0.3924	0.3978	0.4050	0.4076	0.4375	0.3970	0.3970	540	195
1/2	20	0.5000	0.4928	0.4725	0.4712	0.4436	0.4549	0.4603	0.4675	0.4701	0.5000	. . .	0.4576	810	320
9/16	18	0.5625	0.5543	0.5320	0.5305	0.4999	0.5122	0.5182	0.5264	0.5294	0.5625	33/64	0.5156	1,040	410
5/8	18	0.6250	0.6168	0.5945	0.5930	0.5624	0.5747	0.5807	0.5889	0.5919	0.6250	37/64	0.5781	1,430	540
3/4	16	0.7500	0.7410	0.7153	0.7137	0.6792	0.6936	0.7004	0.7094	0.7126	0.7500	. . .	0.6970	2,200	805
7/8	14	0.8750	0.8652	0.8351	0.8333	0.7939	0.8111	0.8188	0.8286	0.8322	0.8750	13/16	0.8125	3,070	1,110
1	14	1.0000	0.9902	0.9605	0.9587	0.9193	0.9361	0.9438	0.9536	0.9572	1.0000	15/16	0.9375	4,590	1,820
1 1/8	12	1.1250	1.1138	1.0784	1.0764	1.0303	1.0507	1.0597	1.0709	1.0749	1.1250	. . .	1.0552	5,620	2,260
1 1/4	12	1.2500	1.2388	1.2031	1.2011	1.1550	1.1757	1.1847	1.1959	1.1996	1.2500	30.0 mm	1.1811	6,960	2,960
1 3/8	12	1.3750	1.3638	1.3276	1.3256	1.2795	1.3007	1.3097	1.3209	1.3241	1.3750	. . .	1.3052	8,440	3,770
1 1/2	12	1.5000	1.4888	1.4521	1.4501	1.4040	1.4257	1.4347	1.4459	1.4486	1.5000	. . .	1.4302	10,070	4,710

TABLE A9 LIMITING DIMENSIONS OF SETTING PLUG AND THREAD WORKING GAGES AND PLAIN DIAMETER GAGES FOR ALTERNATE CLASS 5 FIT THREADED STUDS, AMERICAN NATIONAL COARSE THREAD SERIES

Limiting Dimensions		Size, in.												
		5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
		Threads per inch												
		18	16	14	13	12	11	10	9	8	7	7	6	6
GO Thread Gages for Studs														
Major diameter of full-form setting plug and full portion of truncated setting plug	Max.	0.3176	0.3807	0.4438	0.5068	0.5697	0.6325	0.7579	0.8831	1.0082	1.1333	1.2583	1.3834	1.5089
	Min.	0.3171	0.3801	0.4432	0.5062	0.5691	0.6319	0.7573	0.8824	1.0075	1.1326	1.2576	1.3826	1.5081
Major diameter of truncated portion of truncated setting plug	Max.	0.3043	0.3660	0.4277	0.4896	0.5513	0.6132	0.7372	0.8610	0.9846	1.1080	1.2330	1.3548	1.4798
	Min.	0.3038	0.3654	0.4271	0.4890	0.5507	0.6126	0.7366	0.8603	0.9841	1.1073	1.2323	1.3540	1.4790
Pitch diameter of setting plug and working gages	Max.	0.2810	0.3395	0.3968	0.4562	0.5150	0.5729	0.6923	0.8102	0.9263	1.0398	1.1648	1.2743	1.3998
	Min.	0.2809	0.3394	0.39665	0.45605	0.5148	0.5727	0.6921	0.8100	0.9261	1.0396	1.1646	1.2741	1.3996
Minor diameter of gages	Max.	0.2570	0.3124	0.3659	0.4229	0.4789	0.5335	0.6490	0.7621	0.8722	0.9780	1.1030	1.2022	1.3277
	Min.	0.2565	0.3118	0.3653	0.4223	0.4783	0.5329	0.6484	0.7614	0.8715	0.9773	1.1623	1.2014	1.3269
NOT GO Thread Gages for Studs														
Major diameter of full-form setting plug and full portion of truncated setting plug	Min.	0.3171	0.3801	0.4432	0.5062	0.5691	0.6319	0.7573	0.8824	1.0075	1.1326	1.2576	1.3826	1.5081
	Max.	0.3176	0.3807	0.4438	0.5068	0.5697	0.6325	0.7579	0.8831	1.0082	1.1333	1.2583	1.3834	1.5089
Major diameter of truncated portion of truncated setting plug	Min.	0.3031	0.3644	0.4253	0.4870	0.5485	0.6096	0.7327	0.8552	0.9772	1.0985	1.2235	1.3432	1.4687
	Max.	0.3036	0.3650	0.4259	0.4876	0.5491	0.6102	0.7333	0.8559	0.9779	1.0992	1.2242	1.3440	1.4695
Pitch diameter of setting plug and working gages for production and inspection	Min.	0.2795	0.3379	0.3950	0.4543	0.5130	0.5708	0.6900	0.8078	0.9238	1.0373	1.1623	1.2718	1.3973
	Max.	0.2796	0.3380	0.39515	0.45445	0.5132	0.5710	0.6902	0.8080	0.9240	1.0375	1.1625	1.2720	1.3975
Plain Diameter Gage for Studs														
GO gage for major diameter	Max.	0.31250	0.37500	0.43750	0.50000	0.56250	0.62500	0.75000	0.87500	1.00000	1.12500	1.25000	1.37500	1.50000
	Min.	0.31243	0.37493	0.43743	0.49993	0.56243	0.62493	0.74993	0.87491	0.99991	1.12491	1.24991	1.37491	1.49991
NOT GO gage for major diameter	Min.	0.30430	0.36600	0.42770	0.48960	0.55130	0.61320	0.73720	0.86100	0.98480	1.10800	1.23300	1.35480	1.47980
	Max.	0.30437	0.36607	0.42777	0.48967	0.55137	0.61327	0.73727	0.86109	0.98489	1.10809	1.23309	1.35489	1.47989

TABLE A10 LIMITING DIMENSIONS OF THREAD WORKING GAGES AND PLAIN DIAMETER GAGES FOR ALTERNATE CLASS 5 FIT TAPPED HOLES, AMERICAN NATIONAL COARSE THREAD SERIES

Limiting Dimensions		Size, in. 5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
		Threads per inch 18	16	14	13	12	11	10	9	8	7	7	6	6
GO Thread Gages for Tapped Holes														
Major diameter of working gages	Min.	0.3125	0.3750	0.4375	0.5000	0.5625	0.6250	0.7500	0.8750	1.0000	1.1250	1.2500	1.3750	1.5000
	Max.	0.3130	0.3756	0.4381	0.5006	0.5631	0.6256	0.7506	0.8757	1.0007	1.1257	1.2507	1.3758	1.5008
Pitch diameter of working gages	Min.	0.2764	0.3344	0.3911	0.4500	0.5084	0.5660	0.6850	0.8028	0.9188	1.0322	1.1572	1.2667	1.3917
	Max.	0.2765	0.3345	0.39125	0.45015	0.5086	0.5662	0.6852	0.8030	0.9190	1.0324	1.1574	1.2669	1.3919
NOT GO Thread Gages for Tapped Holes														
Major diameter of working gages	Max.	0.3031	0.3645	0.4252	0.4867	0.5480	0.6090	0.7320	0.8546	0.9766	1.0978	1.2228	1.3426	1.4679
	Min.	0.3026	0.3639	0.4246	0.4861	0.5474	0.6084	0.7314	0.8539	0.9759	1.0971	1.2221	1.3418	1.4671
Pitch diameter of thread working gages for production and inspection	Max.	0.2790	0.3374	0.3943	0.4534	0.5119	0.5696	0.6887	0.8065	0.9225	1.0359	1.1609	1.2704	1.3957
	Min.	0.2789	0.3373	0.39415	0.45325	0.5117	0.5694	0.6885	0.8063	0.9223	1.0357	1.1607	1.2702	1.3955
Plain Diameter Gages for Tapped Holes														
GO gages for minor diameter	Min.	0.26220	0.31860	0.37360	0.43130	0.48820	0.54440	0.66140	0.77680	0.89010	0.99980	1.12480	1.22860	1.35360
	Max.	0.26227	0.31867	0.37367	0.43137	0.48827	0.54447	0.66147	0.77687	0.89019	0.99989	1.12489	1.22869	1.35369
NOT GO gages for minor diameter	Max.	0.26820	0.32540	0.38130	0.43960	0.49720	0.55420	0.67220	0.78880	0.90360	1.01520	1.14020	1.24660	1.37160
	Min.	0.26813	0.32533	0.38123	0.43953	0.49713	0.55413	0.67213	0.78873	0.90351	1.01511	1.14011	1.24651	1.37151

TABLE A11 LIMITING DIMENSIONS OF SETTING PLUG AND THREAD WORKING GAGES AND PLAIN DIAMETER GAGES FOR ALTERNATE CLASS 5 FIT THREADED STUDS, AMERICAN NATIONAL FINE THREAD SERIES

Limiting Dimensions		Size, in.													
		1/4	5/16	3/8	7/16	1/2	9/16	5/8	3/4	7/8	1	1 1/8	1 1/4	1 3/8	1 1/2
		Threads per inch													
		28	24	24	20	20	18	18	16	14	14	12	12	12	12
GO Thread Gages for Studs															
Major diameter of full-form setting plug and full portion of truncated setting plug	Max.	0.2544	0.3172	0.3799	0.4427	0.5055	0.5686	0.6311	0.7565	0.8821	1.0075	1.1331	1.2578	1.3823	1.5068
	Min.	0.2539	0.3167	0.3794	0.4422	0.5050	0.5681	0.6306	0.7559	0.8815	1.0069	1.1325	1.2572	1.3817	1.5062
Major diameter of truncated portion of truncated setting plug	Max.	0.2438	0.3059	0.3684	0.4303	0.4928	0.5543	0.6168	0.7410	0.8652	0.9902	1.1138	1.2388	1.3638	1.4888
	Min.	0.2433	0.3054	0.3679	0.4298	0.4923	0.5538	0.6163	0.7404	0.8646	0.9896	1.1132	1.2382	1.3632	1.4882
Pitch diameter of setting plug and working gage	Max.	0.2307	0.2896	0.3523	0.4097	0.4725	0.5320	0.5945	0.7153	0.8351	0.9605	1.0784	1.2031	1.3276	1.4521
	Min.	0.2306	0.2895	0.3522	0.4096	0.4724	0.53185	0.59435	0.7151	0.8349	0.9603	1.0782	1.2029	1.3274	1.4519
Minor diameter of gages	Max.	0.2152	0.2716	0.3343	0.3881	0.4509	0.5080	0.5705	0.6882	0.8042	0.9296	1.0423	1.1670	1.2915	1.4160
	Min.	0.2147	0.2711	0.3338	0.3876	0.4504	0.5075	0.5700	0.6876	0.8036	0.9290	1.0417	1.1664	1.2909	1.4154
NOT GO Thread Gages for Studs															
Major diameter of full-form setting plug and full portion of truncated setting plug	Min.	0.2539	0.3167	0.3794	0.4422	0.5050	0.5681	0.6306	0.7559	0.8815	1.0069	1.1325	1.2572	1.3817	1.5062
	Max.	0.2544	0.3172	0.3799	0.4427	0.5055	0.5686	0.6311	0.7565	0.8821	1.0075	1.1331	1.2578	1.3823	1.5068
Major diameter of truncated portion of truncated setting plug	Min.	0.2446	0.3059	0.3686	0.4295	0.4923	0.5541	0.6166	0.7402	0.8636	0.9890	1.1119	1.2366	1.3611	1.4856
	Max.	0.2451	0.3064	0.3691	0.4300	0.4928	0.5546	0.6171	0.7408	0.8642	0.9896	1.1125	1.2372	1.3617	1.4862
Pitch diameter of setting plug and working gages for production and inspection	Min.	0.2296	0.2884	0.3511	0.4084	0.4712	0.5305	0.5930	0.7137	0.8333	0.9587	1.0764	1.2011	1.3256	1.4501
	Max.	0.2297	0.2885	0.3512	0.4085	0.4713	0.53065	0.59315	0.7139	0.8335	0.9589	1.0766	1.2013	1.3258	1.4503
Plain Diameter Gages for Studs															
GO gages for major diameter	Max.	0.25000	0.31250	0.37500	0.43750	0.50000	0.56250	0.62500	0.75000	0.87500	1.00000	1.12500	1.25000	1.37500	1.50000
	Min.	0.24993	0.31243	0.37493	0.43743	0.49993	0.56243	0.62493	0.74993	0.87491	0.99991	1.12491	1.24991	1.37491	1.49991
NOT GO gages for major diameter	Min.	0.24380	0.30590	0.36840	0.43030	0.49280	0.55430	0.61680	0.74100	0.86520	0.99020	1.11380	1.23880	1.36380	1.48880
	Max.	0.24387	0.30597	0.36847	0.43037	0.49287	0.55437	0.61687	0.74107	0.86529	0.99029	1.11389	1.23889	1.36389	1.48889

TABLE A12 LIMITING DIMENSIONS OF THREAD WORKING GAGES AND PLAIN DIAMETER GAGES FOR ALTERNATE CLASS 5 FIT TAPPED HOLES, AMERICAN NATIONAL FINE THREAD SERIES

Limiting Dimensions		Size, in.													
		¼	5/16	⅜	7/16	½	9/16	⅝	¾	⅞	1	1⅛	1¼	1⅜	1½
		Threads per inch													
		28	24	24	20	20	18	18	16	14	14	12	12	12	12
GO Thread Gages for Tapped Holes															
Major diameter of working gage	Min.	0.2500	0.3125	0.3750	0.4375	0.5000	0.5625	0.6250	0.7500	0.8750	1.0000	1.1250	1.2500	1.3750	1.5000
	Max.	0.2505	0.3130	0.3755	0.4380	0.5005	0.5630	0.6255	0.7506	0.8756	1.0006	1.1256	1.2506	1.3756	1.5006
Pitch diameter of working gage	Min.	0.2268	0.2854	0.3479	0.4050	0.4675	0.5264	0.5889	0.7094	0.8286	0.9536	1.0709	1.1959	1.3209	1.4459
	Max.	0.2269	0.2855	0.3480	0.4051	0.4676	0.52655	0.58905	0.7096	0.8288	0.9538	1.0711	1.1961	1.3211	1.4461
NOT GO Thread Gages for Tapped Holes															
Major diameter of working gage	Max.	0.2445	0.3058	0.3683	0.4293	0.4918	0.5535	0.6160	0.7397	0.8631	0.9881	1.1110	1.2357	1.3602	1.4847
	Min.	0.2440	0.3053	0.3678	0.4288	0.4913	0.5530	0.6155	0.7391	0.8625	0.9875	1.1104	1.2351	1.3596	1.4841
Pitch diameter of thread working gages for production and inspection	Max.	0.2290	0.2878	0.3503	0.4076	0.4701	0.5294	0.5919	0.7126	0.8322	0.9572	1.0749	1.1996	1.3241	1.4486
	Min.	0.2289	0.2877	0.3502	0.4075	0.4700	0.52925	0.59175	0.7124	0.8320	0.9570	1.0747	1.1994	1.3239	1.4484
Plain Diameter Gages for Tapped Holes															
GO gages for minor diameter	Min.	0.21670	0.27430	0.33680	0.39240	0.45490	0.51220	0.57470	0.69360	0.81110	0.93610	1.05070	1.17570	1.30070	1.42570
	Max.	0.21677	0.27437	0.33687	0.39247	0.45497	0.51227	0.57477	0.69367	0.81117	0.93619	1.05079	1.17579	1.30079	1.42579
NOT GO gages for minor diameter	Max.	0.22060	0.27880	0.34130	0.39780	0.46030	0.51820	0.58070	0.70040	0.81880	0.94380	1.05970	1.18470	1.30970	1.43470
	Min.	0.22053	0.27873	0.34123	0.39773	0.46023	0.51813	0.58063	0.70033	0.81873	0.94371	1.05961	1.18461	1.30961	1.43461

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APPENDIX B
Specifications for Elastic Interference-Fit Thread

(This Appendix is not part of ASME/ANSI B1.12-1987, and is included for information purposes only.)

B1 INTRODUCTION

Appendix B contains useful information that is supplementary to this Standard.

The elastic interference-fit threads are precision threads. The stud and hole are matched for maximum interference. Studs are hardened steel, CRES (corrosion resistant steel), Monel (Monel 400), B16 (ASTM A 193 High Temperature Alloy Steel B16), and K Monel (Monel K500) set in HY-80 steel (80,000 psi yield strength), HTS (high tensile steel hull plate), and cast Monel (Monel 410). Specifications have also proven satisfactory for nonferrous materials. With good geometry parts, successful interference fits with satisfactory resistance to breakloose torque and minimum distortion to the thread form are common. Percentages of interference metal per turn, compared to maximum interference for NC-5 HF/IF at 100%, are greatly reduced for the elastic flow interference-fit thread (see Appendix D, Table D1). These threads are used in ship construction.

B2 THREAD DESIGNATION

B2.1 Class 5 External Thread Made in Monel and Hard Ferrous Material

EXAMPLE: 0.625-11 NC-5 HFM

where

0.625 = nominal size
11 = threads per inch
N = American National thread form
C = coarse thread series
5 = Class 5 Modified tolerance
HF = hard ferrous external thread
M = Monel and K Monel

B2.2 Class 5 Internal Thread Made in Monel, K Monel, and Entire Ferrous Material Hardness Range

EXAMPLE: 0.625-11 NC-5 IFM

where

0.625 = nominal size
11 = threads per inch
N = American National thread form
C = coarse thread series
5 = Class 5 Modified tolerance
I = internal thread
FM = ferrous, Monel, and K Monel materials

B3 EXTERNAL AND INTERNAL THREADS COMPARED TO NC-5

Examination of Tables B1, B2, and B3 on limits of size, tap drill size, length of engagement, and torque reveals the following.

B3.1 Tolerances

Tolerances are smaller than standard National Class 5 threads for ferrous materials.

B3.2 External Thread

(*a*) Maximum major diameter is much smaller than the standard NC-5 threads. The major diameter allowance is approximately equal to $0.020d + 0.001$ in.

(*b*) Major diameter tolerance is 0.002 in. for 1/4, 5/16, and 3/8 sizes, 0.003 in. for 7/16 size, and 0.004 in. for 1/2 in. size and larger.

(*c*) Pitch diameter is always larger than basic pitch diameter.

(*d*) Pitch diameter tolerance is 0.001 in. for 3/8 in. and smaller and 0.002 in. for 9/16 in. and larger.

(*e*) Maximum minor diameter is smaller than basic by 0.006 in. to 0.026 in.

(*f*) Minimum minor diameter is specified.

B3.3 Internal Thread

(*a*) Minimum minor diameter is from 0.005 in. to 0.041 in. greater than basic.

(*b*) Minor diameter tolerance is from 0.008 in. to 0.027 in.

(*c*) Minimum pitch diameter is 0.0003 in. to 0.0023 in. larger than basic pitch diameter.

(*d*) Pitch diameter tolerances increase from 0.0005 in. to 0.0011 in. between ¼ in. and 2 in. sizes.

(*e*) Minimum major diameter is nominal size.

(*f*) Taps have a minimum and maximum pitch diameter tolerance specified.

B3.4 Torque

For assemblies made without a locking resin, the minimum assembly torque shall meet the minimum torque values tabulated in Table B3 or shall be at least one and one-half times the breakloose torque.

B4 APPLICATION PRACTICE FOR NEW AND REWORKED EXTERNAL AND INTERNAL THREADS

B4.1 Additional Conditions of Usage (See Section 10)

The following are for elastic interference-fit threads on which satisfactory application of products made to dimensions in Tables B1 and B2 are predicated.

B4.1.1 External Thread. Studs are measured by size-indicating gages and selected to be within 0.0005 in. of the maximum-interference functional size specified in Table B3 for a reworked tapped hole. The stud shall be of uniform quality and condition and shall not have fins, seams, laps, cracks, burrs, an irregular surface, or other injurious defects detrimental to the performance of the part. The geometry of the stud requires that the measured difference between functional size and pitch diameter size does not exceed 50% of the pitch diameter tolerance.

B4.1.2 Internal Thread. Tapped holes are measured by size-indicating gages. Negative taper in hole (small at entering end) is not permitted. Holes shall be bottom tapped. Geometry of profile and hole is controlled by requiring the difference between measured functional size and pitch diameter size to be within 50% of the pitch diameter tolerance. A hole with a defective thread profile, prior to reassembly, is repaired by retapping with the next larger tap until the profile is restored. Holes are remeasured and studs are matched to holes. In other cases, holes are enlarged to tabulated size to accept stock studs intended for reworking.

B4.1.3 Pitch Diameter Interference

(*a*) *Maximum Pitch Diameter Interference*. Selection of thread assemblies for maximum pitch diameter interference will ensure that the torque values tabulated in Table B3 will be met.

(*b*) *Minimum Pitch Diameter Interference*. An examination of the minimum interference column in Table B3 reveals zero interference on pitch diameter. In practice, when measured external and internal threads are both at minimum material, variations within acceptable limits for lead, angle, taper, roundness, etc., do provide some functional metal-to-metal interference. If the assembly does not meet the torque requirements stated in para. B3.4, a resin sealant may be required to lock the assembly for those applications when sealants are acceptable.

B4.1.4 Resin Sealants. Under specified conditions, reworked assemblies with poor interference or clearance may be locked together with anaerobic sealant. These assemblies may not be subject to temperatures above 200°F.

Before applying sealant, clean parts with oil-free cleaner, dry, and prime with MIL-S-22773 Grade N. Let dry. Use sealant MIL-S-22773 Grade AV when clearance is under 0.005 in. and Grade AVV for larger clearances.

B4.1.5 Surface Roughness. The optimum surface roughness for both external and internal threads was found to be 63 μin. Ra. Values under 125 μin. Ra are recommended. Rougher surfaces are fractured and may release bits of metal during the engagement and get trapped in the interference zone. This results in the need for greater torque with heat generation which may produce more assembly failures. Surface roughness less than 63 μin. Ra may inhibit flow of lubricant, permit buildup of hydraulic pressure, and require higher assembly torque.

B4.1.6 Driving Speed. Torque should be applied smoothly and evenly. Torque readings should continually increase as the length of engagement becomes greater. When K Monel studs are driven into Monel or K Monel holes, a great deal of heat is generated. Driving should be stopped several times to let the heat dissipate. When excessive torque builds up, backing off one or two turns before driving the stud home may reduce the torque 30 or 40 lb–ft on a ⅝ in. thread. The mechanic must determine the optimum driving speed, because type of lubricant, hardness, surface texture, and materials vary with the application.

B4.1.7 Assembly and Disassembly. A set stud must resist rotation when seating and breaking away the prevailing torque nut. Otherwise, the assembly is a failure. After studs are seated, the end faces are scribed with lines, all directed toward the center of the component or some designated point. Rotation resulting from movement of prevailing torque nut can be easily recognized when lines do not line up. When studs are removed during overhaul, questionable profiles are measured and reworked, if necessary. Reapplication up to four times without reworking is feasible, but assembly torque may decrease 60%.

B4.1.8 Acceptability. Acceptability of elastic interference-fit threads shall be determined based upon System 23 of ANSI/ASME B1.3M. The following modifications of System 23 apply.

(*a*) Size-indicating gages are required.

(*b*) Roundness, lead variation, flank angle variation runout, and surface texture are not required.

NOTE: Application may require one or more of these measurements.

B5 GAGING

B5.1 Limits of Size

The limits of size for maximum-material setting gages, specifically for plug gages for external threads and solid ring gages for internal threads, are tabulated in Table B4. Indicating gages need only one reference gage for setting.

B5.2 Unified Class 3A and 3B Setting Gages

Unified Class 3A and 3B setting gages, as tabulated in ANSI/ASME B1.2, may be substituted for the gages in Table B4 if the indicating gages have sufficient travel.