IFI
539
1982

BOUNDARY PROFILE GAGES FOR GAGING OF METRIC SCREW THREADS

SCREW THREADS

IFI NOTES:

IFI-539 was originally published in 1976 as a part of IFI-500. Shortly after publication of IFI-500, ASME Standards Committee B1 used the sections on gages and gaging as the basis of an American Standard which is now under development and when published will be designated ANSI/ASME B1.19M. IFI-539 reflects the contents of the proposed ANSI/ASME B1.19M and when this latter document is published it will supersede IFI-539. Copies of ANSI/ASME B1.19M will be available from the American Society of Mechanical Engineers, United Engineering Center, 345 E. 47th St., New York, NY 10017.

1. SCOPE

1.1 This standard establishes the specifications, dimensions, and use of Boundary Profile Thread Gages for checking the minimum and maximum material boundaries for external and internal screw threads. The minimum material boundary gages are commonly called "Double NOT GO Gages." Gage specifications for screw thread sizes M5 × 0.8 and larger, recommended for metric commercial fasteners in ANSI B1.18M (refer to IFI-500, page A—28) are included. Screw threads, with pitches less than 0.8 mm are considered beyond the feasibility of this gaging method, and gages specified in ANSI B1.16M are applicable.

2. REFERENCES

2.1 American National Standards

ANSI B1.3M-1981, Screw Thread Gaging Systems for Dimensional Acceptability — Metric Screw Threads (M and MJ), page A—35.

ANSI B1.16M (under preparation), American Gaging Practice for Metric Screw Threads.

ANSI B1.18M (under preparation), Metric Screw Threads for Commercial Mechanical Fasteners — Boundary Profile Defined, see IFI-500, page A—28.

ANSI B47.1A-1981, Gage Blanks (Metric Translation of ANSI B47.1-1974).

3. BASIC PRINCIPLES

3.1 Screw Thread Gaging Systems. Screw thread gaging systems are intended to assure that a particular threaded product is able to be assembled with a mating part and that, when assembled, the minimum material limits of the screw threads in the assembly are achieved.

Assembleability in the Boundary Profile system is assured by the use of GO gages, both thread and plain, which establish the maximum material boundary limits. Two NOT GO thread gages are used, which, together, check the minimum material boundary limits of the thread flanks. The boundaries at external thread major and internal thread minor diameters are assured by checking with plain diameter gages. ***(IFI Note: The boundary profile system is System 21A as outlined in ANSI B1.3M, page A—35.)***

3.2 Boundary Profile Gaging. Boundary Profile Gaging is a means of defining a screw thread by establishing a minimum and maximum material boundary and by establishing particular gages and gaging locations for use in inspecting these screw threads. Acceptance of product threads is based on acceptance by the appropriate gages.

4. TYPES OF GAGES

4.1 For External Threads.

4.1.1 The following types of gages are used to verify the maximum material boundary for external threads.

(a) GO thread gages, (Table 1).

(b) Plain ring gage as specified in ANSI B1.16M.

(c) Optical comparator (not shown in this standard) for inspecting minimum radius size and contour of root.

4.1.2 The following types of gages are used to verify the minimum material boundary for external threads.

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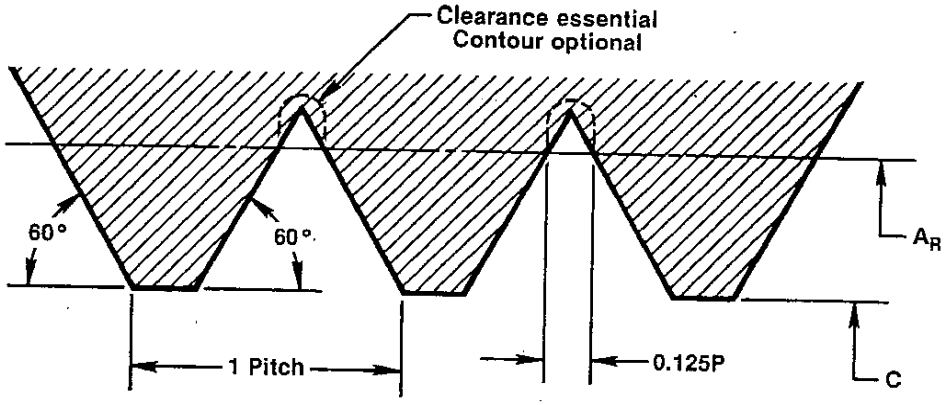

Table 1 GO Thread Gage Contacts — For Gaging Classes 6g and 4g6g External Threads

Basic Major Dia and Thread Pitch	A_R	C		0.125P	Tolerance On Lead	Tolerance On Half Angle
	Dia	Minor Diameter of Gage				
	Min	Max	Tol Minus	Ref	+ or −	+ or −
M5 × 0.8	4.976	4.110	0.013	0.100	0.008	0° 15′
M6 × 1	5.974	4.891	0.013	0.125	0.008	0° 15′
M8 × 1.25	7.972	6.619	0.013	0.156	0.008	0° 15′
M10 × 1.5	9.968	8.344	0.015	0.188	0.008	0° 10′
M12 × 1.75	11.966	10.071	0.015	0.219	0.008	0° 10′
M14 × 2	13.962	11.797	0.015	0.250	0.008	0° 10′
M16 × 2	15.962	13.797	0.015	0.250	0.008	0° 10′
M20 × 2.5	19.958	17.251	0.015	0.313	0.008	0° 10′
M24 × 3	23.952	20.704	0.018	0.375	0.008	0° 10′
M30 × 3.5	29.947	26.158	0.018	0.438	0.010	0° 5′
M36 × 4	35.940	31.610	0.018	0.500	0.010	0° 5′
M42 × 4.5	41.937	37.065	0.020	0.563	0.010	0° 5′
M48 × 5	47.929	42.516	0.020	0.625	0.010	0° 5′
M56 × 5.5	55.925	49.970	0.020	0.688	0.010	0° 5′
M64 × 6	63.920	57.425	0.023	0.750	0.010	0° 5′
M72 × 6	71.920	65.425	0.023	0.750	0.010	0° 5′
M80 × 6	79.920	73.425	0.023	0.750	0.010	0° 5′
M90 × 6	89.920	83.425	0.023	0.750	0.010	0° 5′
M100 × 6	99.920	93.425	0.023	0.750	0.010	0° 5′

Notes:

1. Gage contact dimensions are identical to GO thread gage contacts specified in ANSI B1.16M.
2. Formulas —
   A_R = max major diameter of non-plated external thread as given in IFI-500, Tables 1 and 2.
   $C_{max} = A_r - 1.08253P$
   P = thread pitch
3. Dimensions are in millimeters.

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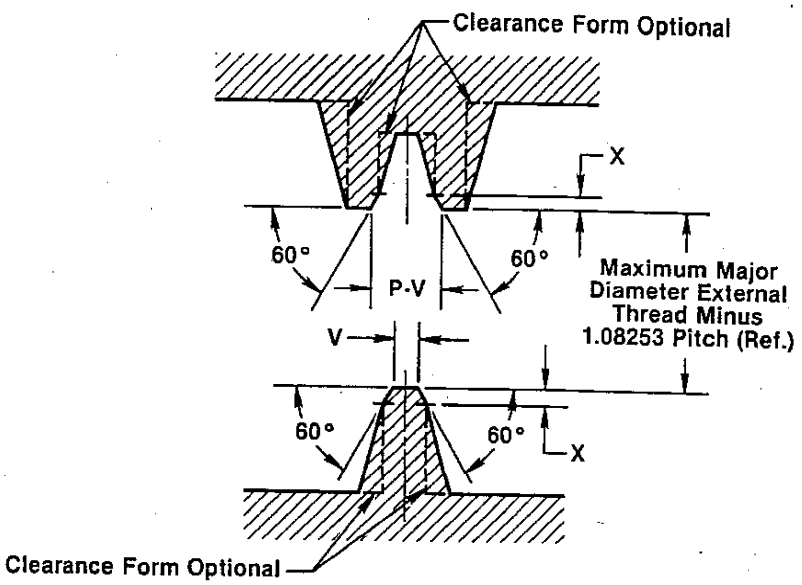

Table 2 NOT GO Thread Gage Contacts — Type B For Gaging Classes 6g and 4g6g External Threads

Basic Major Dia and Thread Pitch	X	V	P-V	Tolerance On Half Angle + or −
M5 × 0.8	0.100 + .030	0.255 ± .008	0.545 ± .008	1° 0′
M6 × 1	0.100 + .030	0.315 ± .008	0.685 ± .008	1° 0′
M8 × 1.25	0.125 + .030	0.381 ± .008	0.869 ± .008	1° 0′
M10 × 1.5	0.150 + .030	0.451 ± .008	1.049 ± .008	1° 0′
M12 × 1.75	0.175 + .036	0.524 ± .008	1.226 ± .008	0° 45′
M14 × 2	0.200 + .040	0.592 ± .010	1.408 ± .010	0° 45′
M16 × 2	0.200 + .040	0.592 ± .010	1.408 ± .010	0° 45′
M20 × 2.5	0.250 + .050	0.723 ± .010	1.777 ± .010	0° 30′
M24 × 3	0.300 + .060	0.865 ± .013	2.135 ± .013	0° 30′
M30 × 3.5	0.350 + .070	0.997 ± .013	2.503 ± .013	0° 30′
M36 × 4	0.400 + .080	1.129 ± .013	2.871 ± .013	0° 20′
M42 × 4.5	0.450 + .090	1.261 ± .015	3.239 ± .015	0° 20′
M48 × 5	0.500 + .100	1.394 ± .015	3.606 ± .015	0° 20′
M56 × 5.5	0.550 + .110	1.528 ± .015	3.972 ± .015	0° 15′
M64 × 6	0.600 + .120	1.662 ± .018	4.338 ± .018	0° 15′
M72 × 6	0.600 + .120	1.662 ± .018	4.338 ± .018	0° 15′
M80 × 6	0.600 + .120	1.662 ± .018	4.338 ± .018	0° 15′
M90 × 6	0.600 + .120	1.662 ± .018	4.338 ± .018	0° 15′
M100 × 6	0.600 + .120	1.673 ± .018	4.327 ± .018	0° 15′

Notes:

1. Formulas —
   X = 0.1P (except for 0.8 mm pitch where X = 0.100 mm)
   P = thread pitch
   V = 0.25P + 0.57735 times flank diametral displacement for class 6g thread (see IFI-500, Table 1).
2. Because of very slight differences and the economy in being able to use a single gage for both tolerance classes of thread, Type C NOT GO thread gage contacts are used for gaging both class 6g and class 4g6g external threads.
3. Dimensions are in millimeters.

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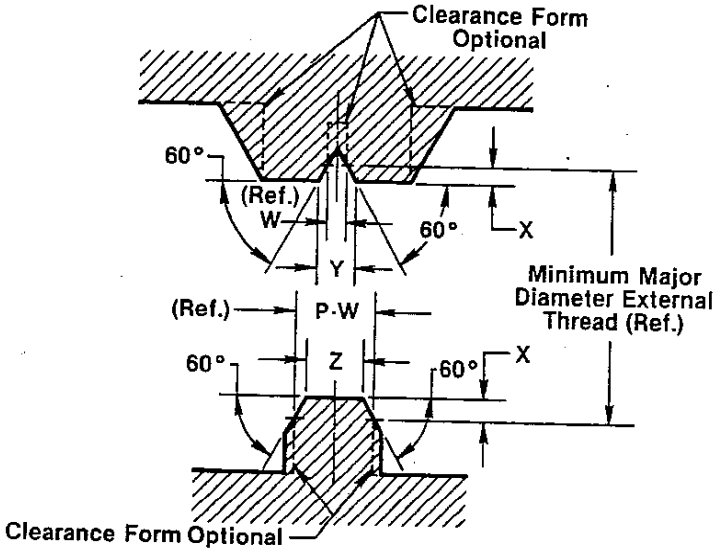

Table 3 NOT GO Thread Gage Contacts — Type C For Gaging Classes 6g and 4g6g External Threads

Basic Major Dia and Thread Pitch	X	Y	Z	Tolerance On Half Angle + or −	W
M5 × 0.8	0.100	0.267 ± .008	0.533 ± .008	1° 0′	0.152
M6 × 1	0.100	0.303 ± .008	0.697 ± .008	1° 0′	0.188
M8 × 1.25	0.125	0.379 ± .008	0.871 ± .008	1° 0′	0.235
M10 × 1.5	0.150	0.448 ± .008	1.052 ± .008	1° 0′	0.275
M12 × 1.75	0.175	0.519 ± .008	1.231 ± .008	0° 45′	0.317
M14 × 2	0.200	0.585 ± .010	1.415 ± .010	0° 45′	0.354
M16 × 2	0.200	0.585 ± .010	1.415 ± .010	0° 45′	0.354
M20 × 2.5	0.250	0.734 ± .010	1.766 ± .010	0° 30′	0.445
M24 × 3	0.300	0.865 ± .013	2.135 ± .013	0° 30′	0.519
M30 × 3.5	0.350	1.011 ± .013	2.489 ± .013	0° 30′	0.607
M36 × 4	0.400	1.155 ± .013	2.845 ± .013	0° 20′	0.693
M42 × 4.5	0.450	1.285 ± .015	3.215 ± .015	0° 20′	0.765
M48 × 5	0.500	1.416 ± .015	3.584 ± .015	0° 20′	0.839
M56 × 5.5	0.550	1.548 ± .015	3.952 ± .015	0° 15′	0.913
M64 × 6	0.600	1.685 ± .018	4.315 ± .018	0° 15′	0.992
M72 × 6	0.600	1.685 ± .018	4.315 ± .018	0° 15′	0.992
M80 × 6	0.600	1.685 ± .018	4.315 ± .018	0° 15′	0.992
M90 × 6	0.600	1.685 ± .018	4.315 ± .018	0° 15′	0.992
M100 × 6	0.600	1.680 ± .018	4.320 ± .018	0° 15′	0.987

Notes:

1. Formulas —
   - X = 0.1P (except for 0.8 mm pitch where X = 0.100 mm).
   - P = thread pitch
   - Y = W + 1.1547X
   - W = crest width at min major diameter of the minimum boundary profile of the external thread for class 4g6g (see IFI-500, Table 2)
   - Z = P − Y
2. Because of very slight differences and the economy in being able to use a single gage for both tolerance classes of thread, Type C NOT GO thread gage contacts are used for gaging both class 6g and class 4g6g external threads.
3. Dimensions are in millimeters.

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(a) NOT GO thread gages, Type B, (Table 2).
(b) NOT GO thread gages, Type C, (Table 3).
(c) Plain snap gage (not shown in this standard) to verify minimum major diameter.

4.2 For Internal Threads.

4.2.1 The following types of gages are used to verify the maximum material boundary for internal threads.

(a) GO thread gages, (Table 4).
(b) Plain plug gages as specified in ANSI B1.16M.

4.2.2 The following types of gages are used to verify the minimum material boundary for internal threads.

(a) NOT GO thread gages Type B, (Table 5).
(b) NOT GO thread gages Type C, (Table 6).
(c) Plain cylindrical gage as specified in ANSI B1.16M.

5. GAGE DIMENSIONS

5.1 General.

5.1.1 The dimensions for thread gage elements, only, are specified in this standard. Limit styles, snap styles or indicating styles of gages, or a mixture of styles as specified in ANSI B1.3M can be used, provided the thread gage elements are within the dimensions specified in this standard; and the gages are produced by acceptable techniques that will result in accurate and repeatable performance. The type of steel or wear resistant material selected, together with the heat-treating and stabilization processes, should provide wear life and dimensional stability.

5.1.2 Design of Gage Blanks. Designs of standard blanks for thread plug and ring gages are shown in ANSI B47.1A.

5.2 For External Threads.

5.2.1 Dimensions for GO thread ring or indicating gage contacts are given in Table 1. These are identical to gages specified in ANSI B1.16M.

5.2.2 Dimensions for Type B NOT GO thread gage contacts are given in Table 2.

5.2.3 Dimensions for Type C NOT GO thread gage contacts are given in Table 3.

5.2.4 Dimensions for GO and NOT GO plain diameter gages for checking whether the external thread crests are within the thread boundaries are not given in this standard. Gages in ANSI B1.16M are used to verify these thread features.

5.2.5 Specifications for optical comparators are not given in this standard. The contour of the external thread can be checked by optical projection.

5.3 For Internal Threads.

5.3.1 Dimensions for GO thread gage contacts are given in Table 4. These are identical to gages specified in ANSI B1.16M.

5.3.2 Dimensions for Type B NOT GO thread gage contacts are given in Table 5.

5.3.3 Dimensions for Type C NOT GO thread gage contacts are given in Table 6. These are identical to HI gages specified in ANSI B1.16M.

5.3.4 Dimensions for GO and NOT GO plain diameter gages for checking whether the internal thread crests are within the thread boundaries are not given in this standard. Gages in ANSI B1.16M are used to verify these thread features.

6. APPLICATION OF GAGES

6.1 For External Threads.

6.1.1 Adjustable GO thread gages must be set to the applicable thread setting plug gage.

6.1.2 The GO thread gage shall assemble freely over the entire thread length of the product, or indicate that the product threads are within the boundary limits.

6.1.3 The Type B and Type C NOT GO thread gages must be set to the applicable setting plug gage. A single setting plug gage is used to set both Type B and Type C gages. The gages listed in Tables 2 and 3 can be used for gaging classes 6g and 4g6g external threads, provided they are set to the appropriate setting plug gage for the required tolerance class.

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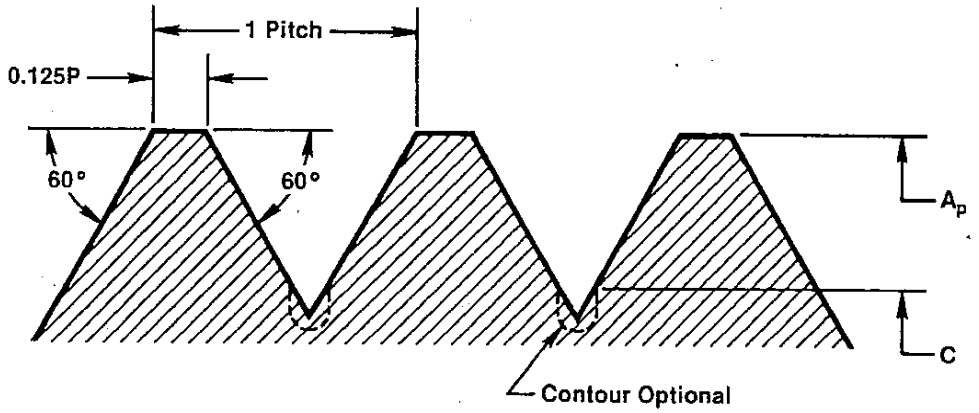

Table 4 GO Thread Gage Contacts — For Gaging Class 6H Internal Threads

Basic Major Dia and Thread Pitch	A_p — Major Dia of Gage		0.125P	C Dia	Tolerance On Lead	Tolerance On Half Angle
	Min	Tol Plus	Ref	Max	+ or −	+ or −
M5 × 0.8	5.000	0.013	0.100	4.134	0.008	0° 15′
M6 × 1	6.000	0.013	0.125	4.917	0.008	0° 15′
M8 × 1.25	8.000	0.013	0.156	6.647	0.008	0° 15′
M10 × 1.5	10.000	0.015	0.188	8.376	0.008	0° 10′
M12 × 1.75	12.000	0.015	0.219	10.106	0.008	0° 10′
M14 × 2	14.000	0.015	0.250	11.835	0.008	0° 10′
M16 × 2	16.000	0.015	0.250	13.835	0.008	0° 10′
M20 × 2.5	20.000	0.015	0.313	17.294	0.008	0° 10′
M24 × 3	24.000	0.018	0.375	20.752	0.008	0° 10′
M30 × 3.5	30.000	0.018	0.438	26.211	0.010	0° 5′
M36 × 4	36.000	0.018	0.500	31.670	0.010	0° 5′
M42 × 4.5	42.000	0.020	0.563	37.129	0.010	0° 5′
M48 × 5	48.000	0.020	0.625	42.587	0.010	0° 5′
M56 × 5.5	56.000	0.020	0.688	50.046	0.010	0° 5′
M64 × 6	64.000	0.023	0.750	57.505	0.010	0° 5′
M72 × 6	72.000	0.023	0.750	65.505	0.010	0° 5′
M80 × 6	80.000	0.023	0.750	73.505	0.010	0° 5′
M90 × 6	90.000	0.023	0.750	83.505	0.010	0° 5′
M100 × 6	100.000	0.023	0.750	93.505	0.010	0° 5′

Notes:

1. GO gage contact dimensions are identical with those for GO thread plug gages specified in ANSI B1.16M.
2. Formulas —
   A_P min = basic major diameter
   P = thread pitch
   C_{max} = min minor diameter of internal thread (see IFI-500, Table 3).
3. Dimensions are in millimeters.

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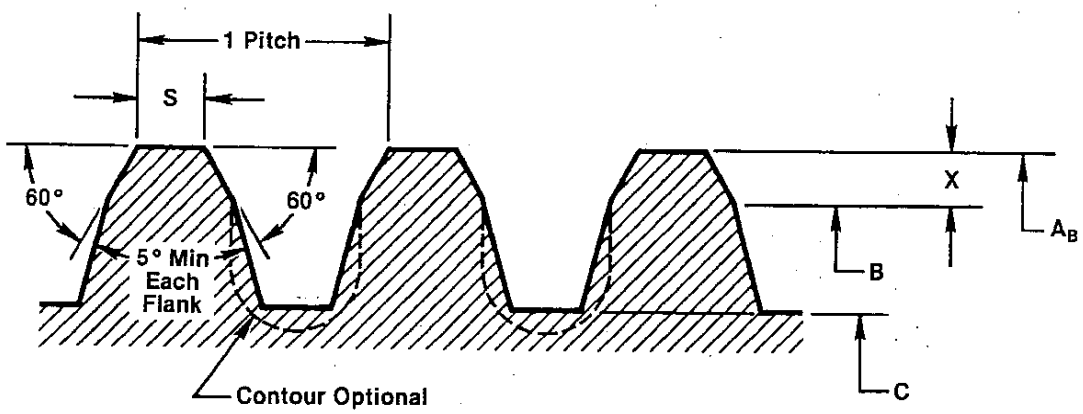

Table 5 NOT GO Thread Gage Contacts — Type B — For Gaging Class 6H Internal Threads

Basic Major Dia and Thread Pitch	A_B — Major Dia of Gage		B Dia	C Dia	S	X		Tolerance On Lead	Tolerance On Half Angle
	Max	Tol Minus	Ref	Max		Nom	Tol + or −	+ or −	+ or −
M5 × 0.8	5.000	0.013	4.800	4.134	0.172	0.100	0.015	0.008	1° 0′
M6 × 1	6.000	0.013	5.800	4.917	0.212	0.100	0.015	0.008	1° 0′
M8 × 1.25	8.000	0.013	7.750	6.647	0.249	0.125	0.015	0.008	1° 0′
M10 × 1.5	10.000	0.015	9.700	8.376	0.291	0.150	0.015	0.008	1° 0′
M12 × 1.75	12.000	0.015	11.650	10.106	0.334	0.175	0.018	0.008	0° 45′
M14 × 2	14.000	0.015	13.600	11.835	0.372	0.200	0.020	0.008	0° 45′
M16 × 2	16.000	0.015	15.600	13.835	0.372	0.200	0.020	0.008	0° 45′
M20 × 2.5	20.000	0.015	19.500	17.294	0.442	0.250	0.025	0.008	0° 30′
M24 × 3	24.000	0.018	23.400	20.752	0.528	0.300	0.030	0.008	0° 30′
M30 × 3.5	30.000	0.018	29.300	26.211	0.599	0.350	0.035	0.010	0° 30′
M36 × 4	36.000	0.018	35.200	31.670	0.673	0.400	0.040	0.010	0° 20′
M42 × 4.5	42.000	0.020	41.100	37.129	0.744	0.450	0.045	0.010	0° 20′
M48 × 5	48.000	0.020	47.000	42.587	0.818	0.500	0.050	0.010	0° 20′
M56 × 5.5	56.000	0.020	54.900	50.046	0.892	0.550	0.055	0.010	0° 15′
M64 × 6	64.000	0.023	62.800	57.505	0.967	0.600	0.060	0.010	0° 15′
M72 × 6	72.000	0.023	70.800	65.505	0.967	0.600	0.060	0.010	0° 15′
M80 × 6	80.000	0.023	78.800	73.505	0.967	0.600	0.060	0.010	0° 15′
M90 × 6	90.000	0.023	88.800	83.505	0.967	0.600	0.060	0.010	0° 15′
M100 × 6	100.000	0.023	98.800	93.505	0.981	0.600	0.060	0.010	0° 15′

Notes:

1. Formulas —
   A_B max = basic major diameter
   X = 0.1P (except for 0.8 mm pitch where X = 0.100 mm)
   B = A_B − 2X
   C max = basic major diameter — 1.08253 P
   P = thread pitch
   S = 0.125P + 0.57735 times the flank diametral displacement for class 6H (see IFI-500, Table 3).
3. Dimensions are in millimeters.

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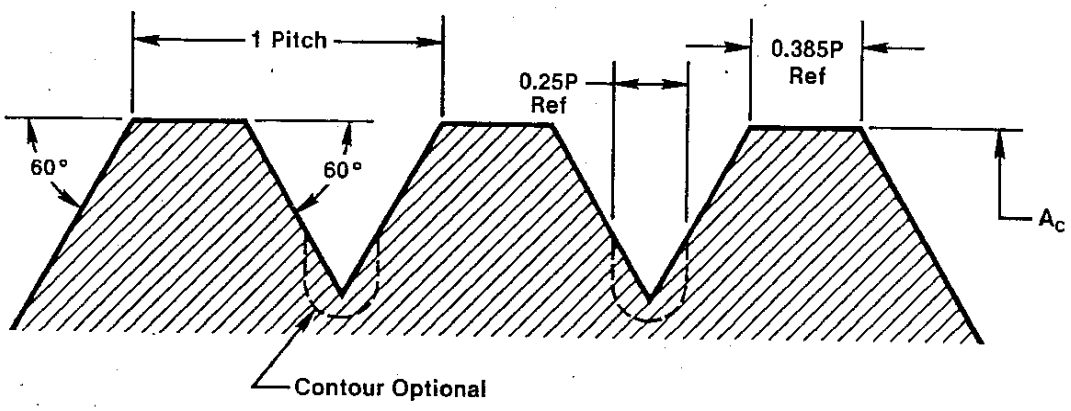

Table 6 NOT GO Thread Gage Contacts — Type C For Gaging Class 6H Internal Threads

Basic Major Dia and Thread Pitch	A_C — Major Dia of Gage		Tolerance On Lead	Tolerance On Half Angle
	Max	Tol Minus	+ or −	+ or −
M5 × 0.8	4.765	0.013	0.008	0° 15′
M6 × 1	5.700	0.013	0.008	0° 15′
M8 × 1.25	7.598	0.013	0.008	0° 15′
M10 × 1.5	9.506	0.015	0.008	0° 10′
M12 × 1.75	11.413	0.015	0.008	0° 10′
M14 × 2	13.313	0.015	0.008	0° 10′
M16 × 2	15.313	0.015	0.008	0° 10′
M20 × 2.5	19.100	0.015	0.008	0° 10′
M24 × 3	22.916	0.018	0.008	0° 10′
M30 × 3.5	28.707	0.018	0.010	0° 5′
M36 × 4	34.502	0.018	0.010	0° 5′
M42 × 4.5	40.292	0.020	0.010	0° 5′
M48 × 5	46.087	0.020	0.010	0° 5′
M56 × 5.5	53.883	0.020	0.010	0° 5′
M64 × 6	61.678	0.023	0.010	0° 5′
M72 × 6	69.678	0.023	0.010	0° 5′
M80 × 6	77.678	0.023	0.010	0° 5′
M90 × 6	87.678	0.023	0.010	0° 5′
M100 × 6	97.703	0.023	0.010	0° 5′

Notes:

1. Gage contact dimensions are identical to those for the HI thread plug gage specified in ANSI B1.16M.
2. Formulas —

   A_C max = D − 0.44952P + the flank diametral displacement for class 6H (see IFI-500, Table 3).

   D = basic major diameter

   P = thread pitch
3. Dimensions are in millimeters.

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(IFI Note: Setting plug data is not included in this standard but will be included in ANSI B1.19M.)

6.1.4 Type B and Type C NOT GO thread gages shall be applied to the product threads at various positions around the circumference and along the length of thread. Neither of the two NOT GO gages shall pass over the threads in any position, nor indicate that the product threads are not within boundary limits, except for the permitted length of incomplete threads.

When using snap gages, the force applied to the product threads shall not exceed a force of 5 newtons when inspecting threads with pitches 1 mm and finer, and 12 newtons for threads with pitches 1.25 mm and coarser.

NOTE: Snap gages may cam over threads with rough surface texture and conceivably may reject parts within tolerance. A reasonable criterion of acceptance is to declare the thread acceptable even though a NOT GO snap gage may pass over the product thread in one or two locations providing that the same gage finds the thread acceptable in numerous other locations throughout its length and circumference.

6.1.5 The maximum and minimum major diameters of the product external threads shall be gaged with plain diameter gages over the length of thread.

6.1.6 The radius size and contour of the thread root shall be inspected by optical comparator method. A magnification of 50× for thread pitches 1.5 mm and finer and 20× for thread pitches coarser than 1.5 mm is recommended. Surface roughness visible under magnification shall not be cause for rejection.

6.2 For Internal Threads.

6.2.1 Acceptability at the maximum material of the product internal thread flanks shall be based on gaging with GO thread gages.

6.2.2 The GO thread gage shall assemble freely with the entire thread length of the product, or indicate that these product threads are within boundary limits.

6.2.3 The Type B and Type C NOT GO gages shall be applied to the product threads at various positions around the circumference and along the length of thread. Neither of the two gages shall allow the product threads to be out of tolerance in any position, except for the permitted length of incomplete threads. When using NOT GO thread plug gages, neither of the two gages (B and C) shall enter the product threads beyond two full turns of thread engagement from either end of nut.

6.2.4 The maximum and minimum minor diameters of the product internal threads shall be gaged with plain diameter gages over the length of thread.

7. MARKING OF GAGES

7.1 NOT GO thread gages made to this standard should be marked with the basic thread designation plus "NOT GO B" or NOT GO C."

Example: M14 × 2 — NOT GO C

7.2 Gages made to ANSI B1.16M are marked in accordance with ANSI B1.16M.