

IE-352
Section 1, CRN: 48700/1/2
Section 2, CRN: 48706/7/8
Second Semester 1435-36 H (Spring-2015) – 4(4,1,2)
“MANUFACTURING PROCESSES – 2”

Thursday, March 05, 2015 (14/05/1436H)

Quiz 3 ANSWERS

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Given the following information for a shaft-hole system,

Nominal Size = $\frac{11}{16}$ "

LT5 fit

Nominal Size Range, Inches Over To		Class LT 5		
		Fit ^a	Std. Tolerance Limits	
			Hole H7	Shaft n6
0 –	0.12	-0.5 +0.15	+0.4 0	+0.5 +0.25
0.12 –	0.24	-0.6 +0.2	+0.5 0	+0.6 +0.3
0.24 –	0.40	-0.8 +0.2	+0.6 0	+0.8 +0.4
0.40 –	0.71	-0.9 +0.2	+0.7 0	+0.9 +0.5
0.71 –	1.19	-1.1 +0.2	+0.8 0	+1.1 +0.6
1.19 –	1.97	-1.3 +0.3	+1.0 0	+1.3 +0.7
1.97 –	3.15	-1.5 +0.4	+1.2 0	+1.5 +0.8

1. What is the basic size? [1 Point]

ANSWER: **0.6875"**

$BS = \frac{11}{16} = 0.6875 \text{ in}$ (note, answer must be expressed to 4 d.p.)

2. What is the shaft MMC? [1 Point]

ANSWER: **0.6884**

$MMC = BS + (+0.0009) = 0.6875 + 0.0009 = 0.6884$

3. What is the hole MMC? [1 Point]

ANSWER: **0.6875**

$MMC = BS$ (since basic hole system) = 0.6875

4. What is the shaft LMC? [1 Point]

ANSWER:

0.6880

$$LMC = BS + (+0.0005) = 0.6875 + 0.0005 = 0.6880$$

5. What is the hole LMC? [1 Point]

ANSWER:

0.6882

$$LMC = BS + (+0.0007) = 0.6875 + 0.0007 = 2.3762$$

6. Express the hole and shaft sizes below in the specified formats [$\frac{1}{2}$ pt. each]

	Hole Size	Shaft Size
a) Stacked Form	$\phi 0.6882$ ← LMC $\phi 0.6875$ ← MMC	$\phi 0.6884$ $\phi 0.6880$
b) Referenced to Basic Size Form	$\phi 0.6875 \begin{smallmatrix} +0.0007 \\ 0 \end{smallmatrix}$	$\phi 0.6875 \begin{smallmatrix} +0.0009 \\ +0.0005 \end{smallmatrix}$

7. What is the maximum *clearance*? [1 Point]

ANSWER:

0.0002

$$\begin{aligned} \text{maximum clearance} &= \text{clearance at LMC} = \text{hole}_{LMC} - \text{shaft}_{LMC} \\ &= 0.6882 - 0.6880 = 0.0002 \end{aligned}$$

Note, get from fits data, then check from table above (e.g. stacked form)

8. What is the maximum *interference*? [1 Point]

ANSWER:

0.0009

$$\begin{aligned} \text{maximum intereference} &= \text{shaft}_{MMC} - \text{hole}_{MMC} = 0.6884 - 0.6875 \\ &= 0.0009 \end{aligned}$$

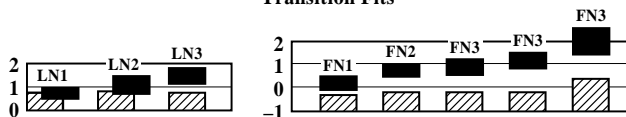
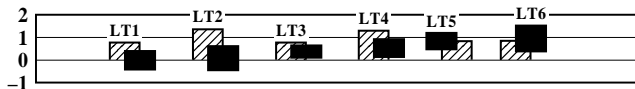
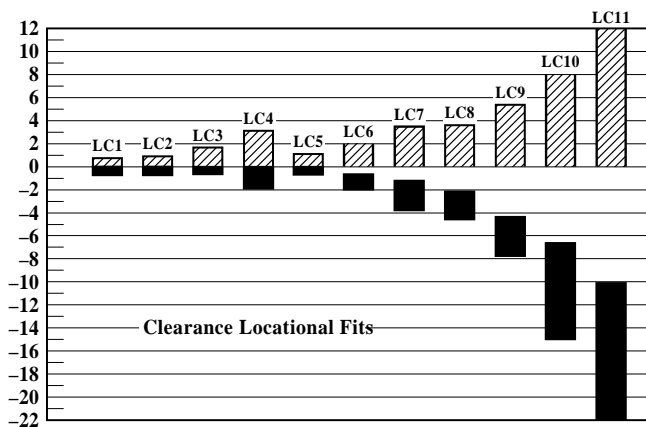
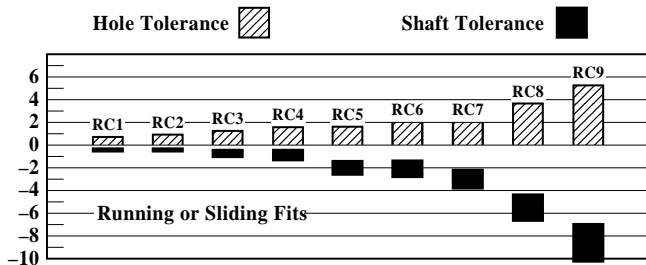
Note, get from fits data, then check from table above (e.g. stacked form)

9. What standard fit *category* is this system? [1 Point]

ANSWER:

Location fit

Graphical Representation of ANSI Standard Limits and Fits



Diagrams show disposition of hole and shaft tolerances (in thousandths of an inch) with respect to basic size (0) for a diameter of 1 inch.

Table 3. American National Standard Running and Sliding Fits ANSI B4.1-1967 (R1987)

Nominal Size Range, Inches	Class RC 1			Class RC 2			Class RC 3			Class RC 4		
	Clear- ance ^a	Standard Tolerance Limits		Clearance ^a	Standard Tolerance Limits		Clearance ^a	Standard Tolerance Limits		Clearance ^a	Standard Tolerance Limits	
		Hole H5	Shaft g4		Hole H6	Shaft g5		Hole H7	Shaft f6		Hole H8	Shaft f7
Over To	Values shown below are in thousandths of an inch											
0 - 0.12	0.1 0.45	+0.2 0	-0.1 -0.25	0.1 0.55	+0.25 0	-0.1 -0.3	0.3 0.95	+0.4 0	-0.3 -0.55	0.3 1.3	+0.6 0	-0.3 -0.7
0.12 - 0.24	0.15 0.5	+0.2 0	-0.15 -0.3	0.15 0.65	+0.3 0	-0.15 -0.35	0.4 1.12	+0.5 0	-0.4 -0.7	0.4 1.6	+0.7 0	-0.4 -0.9
0.24 - 0.40	0.2 0.6	+0.25 0	-0.2 -0.35	0.2 0.85	+0.4 0	-0.2 -0.45	0.5 1.5	+0.6 0	-0.5 -0.9	0.5 2.0	+0.9 0	-0.5 -1.1
0.40 - 0.71	0.25 0.75	+0.3 0	-0.25 -0.45	0.25 0.95	+0.4 0	-0.25 -0.55	0.6 1.7	+0.7 0	-0.6 -1.0	0.6 2.3	+1.0 0	-0.6 -1.3
0.71 - 1.19	0.3 0.95	+0.4 0	-0.3 -0.55	0.3 1.2	+0.5 0	-0.3 -0.7	0.8 2.1	+0.8 0	-0.8 -1.3	0.8 2.8	+1.2 0	-0.8 -1.6
1.19 - 1.97	0.4 1.1	+0.4 0	-0.4 -0.7	0.4 1.4	+0.6 0	-0.4 -0.8	1.0 2.6	+1.0 0	-1.0 -1.6	1.0 3.6	+1.6 0	-1.0 -2.0
1.97 - 3.15	0.4 1.2	+0.5 0	-0.4 -0.7	0.4 1.6	+0.7 0	-0.4 -0.9	1.2 3.1	+1.2 0	-1.2 -1.9	1.2 4.2	+1.8 0	-1.2 -2.4
3.15 - 4.73	0.5 1.5	+0.6 0	-0.5 -0.9	0.5 2.0	+0.9 0	-0.5 -1.1	1.4 3.7	+1.4 0	-1.4 -2.3	1.4 5.0	+2.2 0	-1.4 -2.8
4.73 - 7.09	0.6 1.8	+0.7 0	-0.6 -1.1	0.6 2.3	+1.0 0	-0.6 -1.3	1.6 4.2	+1.6 0	-1.6 -2.6	1.6 5.7	+2.5 0	-1.6 -3.2
7.09 - 9.85	0.6 2.0	+0.8 0	-0.6 -1.2	0.6 2.6	+1.2 0	-0.6 -1.4	2.0 5.0	+1.8 0	-2.0 -3.2	2.0 6.6	+2.8 0	-2.0 -3.8
9.85 - 12.41	0.8 2.3	+0.9 0	-0.8 -1.4	0.8 2.9	+1.2 0	-0.8 -1.7	2.5 5.7	+2.0 0	-2.5 -3.7	2.5 7.5	+3.0 0	-2.5 -4.5
12.41 - 15.75	1.0 2.7	+1.0 0	-1.0 -1.7	1.0 3.4	+1.4 0	-1.0 -2.0	3.0 6.6	+2.2 0	-3.0 -4.0	3.0 8.7	+3.5 0	-3.0 -5.2
15.75 - 19.69	1.2 3.0	+1.0 0	-1.2 -2.0	1.2 3.8	+1.6 0	-1.2 -2.2	4.0 8.1	+2.5 0	-4.0 -5.6	4.0 10.5	+4.0 0	-4.0 -6.5

^aPairs of values shown represent minimum and maximum amounts of clearance resulting from application of standard tolerance limits.

Table 4. American National Standard Running and Sliding Fits ANSI B4.1-1967 (R1987)

Nominal Size Range, Inches		Class RC 5			Class RC 6			Class RC 7			Class RC 8			Class RC 9		
		Clearance ^a	Standard Tolerance Limits		Clearance ^a	Standard Tolerance Limits		Clearance ^a	Standard Tolerance Limits		Clearance ^a	Standard Tolerance Limits		Clearance ^a	Standard Tolerance Limits	
			Hole H8	Shaft e7		Hole H9	Shaft e8		Hole H9	Shaft d8		Hole H10	Shaft e9		Hole H11	Shaft
Over	To	Values shown below are in thousandths of an inch														
0 – 0.12		0.6 1.6	+0.6 0	-0.6 -1.0	0.6 2.2	+1.0 0	-0.6 -1.2	1.0 2.6	+1.0 0	-1.0 -1.6	2.5 5.1	+1.6 0	-2.5 -3.5	4.0 8.1	+2.5 0	-4.0 -5.6
0.12 – 0.24		0.8 2.0	+0.7 0	-0.8 -1.3	0.8 2.7	+1.2 0	-0.8 -1.5	1.2 3.1	+1.2 0	-1.2 -1.9	2.8 5.8	+1.8 0	-2.8 -4.0	4.5 9.0	+3.0 0	-4.5 -6.0
0.24 – 0.40		1.0 2.5	+0.9 0	-1.0 -1.6	1.0 3.3	+1.4 0	-1.0 -1.9	1.6 3.9	+1.4 0	-1.6 -2.5	3.0 6.6	+2.2 0	-3.0 -4.4	5.0 10.7	+3.5 0	-5.0 -7.2
0.40 – 0.71		1.2 2.9	+1.0 0	-1.2 -1.9	1.2 3.8	+1.6 0	-1.2 -2.2	2.0 4.6	+1.6 0	-2.0 -3.0	3.5 7.9	+2.8 0	-3.5 -5.1	6.0 12.8	+4.0 0	-6.0 -8.8
0.71 – 1.19		1.6 3.6	+1.2 0	-1.6 -2.4	1.6 4.8	+2.0 0	-1.6 -2.8	2.5 5.7	+2.0 0	-2.5 -3.7	4.5 10.0	+3.5 0	-4.5 -6.5	7.0 15.5	+5.0 0	-7.0 -10.5
1.19 – 1.97		2.0 4.6	+1.6 0	-2.0 -3.0	2.0 6.1	+2.5 0	-2.0 -3.6	3.0 7.1	+2.5 0	-3.0 -4.6	5.0 11.5	+4.0 0	-5.0 -7.5	8.0 18.0	+6.0 0	-8.0 -12.0
1.97 – 3.15		2.5 5.5	+1.8 0	-2.5 -3.7	2.5 7.3	+3.0 0	-2.5 -4.3	4.0 8.8	+3.0 0	-4.0 -5.8	6.0 13.5	+4.5 0	-6.0 -9.0	9.0 20.5	+7.0 0	-9.0 -13.5
3.15 – 4.73		3.0 6.6	+2.2 0	-3.0 -4.4	3.0 8.7	+3.5 0	-3.0 -5.2	5.0 10.7	+3.5 0	-5.0 -7.2	7.0 15.5	+5.0 0	-7.0 -10.5	10.0 24.0	+9.0 0	-10.0 -15.0
4.73 – 7.09		3.5 7.6	+2.5 0	-3.5 -5.1	3.5 10.0	+4.0 0	-3.5 -6.0	6.0 12.5	+4.0 0	-6.0 -8.5	8.0 18.0	+6.0 0	-8.0 -12.0	12.0 28.0	+10.0 0	-12.0 -18.0
7.09 – 9.85		4.0 8.6	+2.8 0	-4.0 -5.8	4.0 11.3	+4.5 0	-4.0 -6.8	7.0 14.3	+4.5 0	-7.0 -9.8	10.0 21.5	+7.0 0	-10.0 -14.5	15.0 34.0	+12.0 0	-15.0 -22.0
9.85 – 12.41		5.0 10.0	+3.0 0	-5.0 -7.0	5.0 13.0	+5.0 0	-5.0 -8.0	8.0 16.0	+5.0 0	-8.0 -11.0	12.0 25.0	+8.0 0	-12.0 -17.0	18.0 38.0	+12.0 0	-18.0 -26.0
12.41 – 15.75		6.0 11.7	+3.5 0	-6.0 -8.2	6.0 15.5	+6.0 0	-6.0 -9.5	10.0 19.5	+6.0 0	-10.0 -13.5	14.0 29.0	+9.0 0	-14.0 -20.0	22.0 45.0	+14.0 0	-22.0 -31.0
15.75 – 19.69		8.0 14.5	+4.0 0	-8.0 -10.5	8.0 18.0	+6.0 0	-8.0 -12.0	12.0 22.0	+6.0 0	-12.0 -16.0	16.0 32.0	+10.0 0	-16.0 -22.0	25.0 51.0	+16.0 0	-25.0 -35.0

Tolerance limits given in body of table are added to or subtracted from basic size (as indicated by + or - sign) to obtain maximum and minimum sizes of mating parts.

All data above heavy lines are in accord with ABC agreements. Symbols H5, g4, etc. are hole and shaft designations in ABC system. Limits for sizes above 19.69 inches are also given in the ANSI Standard.

Table 5. American National Standard Clearance Locational Fits ANSI B4.1-1967 (R1987)

Nominal Size Range, Inches	Class LC 1			Class LC 2			Class LC 3			Class LC 4			Class LC 5		
	Clear- ance ^a	Standard Tolerance Limits		Clear- ance ^a	Standard Tolerance Limits		Clear- ance ^a	Standard Tolerance Limits		Clear- ance ^a	Standard Tolerance Limits		Clear- ance ^a	Standard Tolerance Limits	
		Hole H6	Shaft h5		Hole H7	Shaft h6		Hole H8	Shaft h7		Hole H10	Shaft h9		Hole H7	Shaft g6
Over To	Values shown below are in thousandths of an inch														
0- 0.12	0 0.45	+0.25 0	0 -0.2	0 0.65	+0.4 0	0 -0.25	0 1	+0.6 0	0 -0.4	0 2.6	+1.6 0	0 -1.0	0.1 0.75	+0.4 0	-0.1 -0.35
0.12- 0.24	0 0.5	+0.3 0	0 -0.2	0 0.8	+0.5 0	0 -0.3	0 1.2	+0.7 0	0 -0.5	0 3.0	+1.8 0	0 -1.2	0.15 0.95	+0.5 0	-0.15 -0.45
0.24- 0.40	0 0.65	+0.4 0	0 -0.25	0 1.0	+0.6 0	0 -0.4	0 1.5	+0.9 0	0 -0.6	0 3.6	+2.2 0	0 -1.4	0.2 1.2	+0.6 0	-0.2 -0.6
0.40- 0.71	0 0.7	+0.4 0	0 -0.3	0 1.1	+0.7 0	0 -0.4	0 1.7	+1.0 0	0 -0.7	0 4.4	+2.8 0	0 -1.6	0.25 1.35	+0.7 0	-0.25 -0.65
0.71- 1.19	0 0.9	+0.5 0	0 -0.4	0 1.3	+0.8 0	0 -0.5	0 2	+1.2 0	0 -0.8	0 5.5	+3.5 0	0 -2.0	0.3 1.6	+0.8 0	-0.3 -0.8
1.19- 1.97	0 1.0	+0.6 0	0 -0.4	0 1.6	+1.0 0	0 -0.6	0 2.6	+1.6 0	0 -1	0 6.5	+4.0 0	0 -2.5	0.4 2.0	+1.0 0	-0.4 -1.0
1.97- 3.15	0 1.2	+0.7 0	0 -0.5	0 1.9	+1.2 0	0 -0.7	0 3	+1.8 0	0 -1.2	0 7.5	+4.5 0	0 -3	0.4 2.3	+1.2 0	-0.4 -1.1
3.15- 4.73	0 1.5	+0.9 0	0 -0.6	0 2.3	+1.4 0	0 -0.9	0 3.6	+2.2 0	0 -1.4	0 8.5	+5.0 0	0 -3.5	0.5 2.8	+1.4 0	-0.5 -1.4
4.73- 7.09	0 1.7	+1.0 0	0 -0.7	0 2.6	+1.6 0	0 -1.0	0 4.1	+2.5 0	0 -1.6	0 10.0	+6.0 0	0 -4	0.6 3.2	+1.6 0	-0.6 -1.6
7.09- 9.85	0 2.0	+1.2 0	0 -0.8	0 3.0	+1.8 0	0 -1.2	0 4.6	+2.8 0	0 -1.8	0 11.5	+7.0 0	0 -4.5	0.6 3.6	+1.8 0	-0.6 -1.8
9.85- 12.41	0 2.1	+1.2 0	0 -0.9	0 3.2	+2.0 0	0 -1.2	0 5	+3.0 0	0 -2.0	0 13.0	+8.0 0	0 -5	0.7 3.9	+2.0 0	-0.7 -1.9
12.41- 15.75	0 2.4	+1.4 0	0 -1.0	0 3.6	+2.2 0	0 -1.4	0 5.7	+3.5 0	0 -2.2	0 15.0	+9.0 0	0 -6	0.7 4.3	+2.2 0	-0.7 -2.1
15.75- 19.69	0 2.6	+1.6 0	0 -1.0	0 4.1	+2.5 0	0 -1.6	0 6.5	+4 0	0 -2.5	0 16.0	+10.0 0	0 -6	0.8 4.9	+2.5 0	-0.8 -2.4

^aPairs of values shown represent minimum and maximum amounts of interference resulting from application of standard tolerance limits.

Table 6. American National Standard Clearance Locational Fits ANSI B4.1-1967 (R1987)

Nominal Size Range, Inches	Class LC 6			Class LC 7			Class LC 8			Class LC 9			Class LC 10			Class LC 11		
	Clearance ^a	Std. Tolerance Limits		Clearance ^a	Std. Tolerance Limits		Clearance ^a	Std. Tolerance Limits		Clearance ^a	Std. Tolerance Limits		Clearance ^a	Std. Tolerance Limits		Clearance ^a	Std. Tolerance Limits	
		Hole H9	Shaft f8		Hole H10	Shaft e9		Hole H10	Shaft d9		Hole H11	Shaft c10		Hole H12	Shaft		Hole H13	Shaft
Over To	Values shown below are in thousandths of an inch																	
0 - 0.12	0.3 1.9	+1.0 0	-0.3 -0.9	0.6 3.2	+1.6 0	-0.6 -1.6	1.0 2.0	+1.6 0	-1.0 -2.0	2.5 6.6	+2.5 0	-2.5 -4.1	4 12	+4 0	-4 -8	5 17	+6 0	-5 -11
0.12 - 0.24	0.4 2.3	+1.2 0	-0.4 -1.1	0.8 3.8	+1.8 0	-0.8 -2.0	1.2 4.2	+1.8 0	-1.2 -2.4	2.8 7.6	+3.0 0	-2.8 -4.6	4.5 14.5	+5 0	-4.5 -9.5	6 20	+7 0	-6 -13
0.24 - 0.40	0.5 2.8	+1.4 0	-0.5 -1.4	1.0 4.6	+2.2 0	-1.0 -2.4	1.6 5.2	+2.2 0	-1.6 -3.0	3.0 8.7	+3.5 0	-3.0 -5.2	5 17	+6 0	-5 -11	7 25	+9 0	-7 -16
0.40 - 0.71	0.6 3.2	+1.6 0	-0.6 -1.6	1.2 5.6	+2.8 0	-1.2 -2.8	2.0 6.4	+2.8 0	-2.0 -3.6	3.5 10.3	+4.0 0	-3.5 -6.3	6 20	+7 0	-6 -13	8 28	+10 0	-8 -18
0.71 - 1.19	0.8 4.0	+2.0 0	-0.8 -2.0	1.6 7.1	+3.5 0	-1.6 -3.6	2.5 8.0	+3.5 0	-2.5 -4.5	4.5 13.0	+5.0 0	-4.5 -8.0	7 23	+8 0	-7 -15	10 34	+12 0	-10 -22
1.19 - 1.97	1.0 5.1	+2.5 0	-1.0 -2.6	2.0 8.5	+4.0 0	-2.0 -4.5	3.6 9.5	+4.0 0	-3.0 -5.5	5.0 15.0	+6 0	-5.0 -9.0	8 28	+10 0	-8 -18	12 44	+16 0	-12 -28
1.97 - 3.15	1.2 6.0	+3.0 0	-1.0 -3.0	2.5 10.0	+4.5 0	-2.5 -5.5	4.0 11.5	+4.5 0	-4.0 -7.0	6.0 17.5	+7 0	-6.0 -10.5	10 34	+12 0	-10 -22	14 50	+18 0	-14 -32
3.15 - 4.73	1.4 7.1	+3.5 0	-1.4 -3.6	3.0 11.5	+5.0 0	-3.0 -6.5	5.0 13.5	+5.0 0	-5.0 -8.5	7 21	+9 0	-7 -12	11 39	+14 0	-11 -25	16 60	+22 0	-16 -38
4.73 - 7.09	1.6 8.1	+4.0 0	-1.6 -4.1	3.5 13.5	+6.0 0	-3.5 -7.5	6 16	+6 0	-6 -10	8 24	+10 0	-8 -14	12 44	+16 0	-12 -28	18 68	+25 0	-18 -43
7.09 - 9.85	2.0 9.3	+4.5 0	-2.0 -4.8	4.0 15.5	+7.0 0	-4.0 -8.5	7 18.5	+7 0	-7 -11.5	10 29	+12 0	-10 -17	16 52	+18 0	-16 -34	22 78	+28 0	-22 -50
9.85 - 12.41	2.2 10.2	+5.0 0	-2.2 -5.2	4.5 17.5	+8.0 0	-4.5 -9.5	7 20	+8 0	-7 -12	12 32	+12 0	-12 -20	20 60	+20 0	-20 -40	28 88	+30 0	-28 -58
12.41 - 15.75	2.5 12.0	+6.0 0	-2.5 -6.0	5.0 20.0	+9.0 0	-5 -11	8 23	+9 0	-8 -14	14 37	+14 0	-14 -23	22 66	+22 0	-22 -44	30 100	+35 0	-30 -65
15.75 - 19.69	2.8 12.8	+6.0 0	-2.8 -6.8	5.0 21.0	+10.0 0	-5 -11	9 25	+10 0	-9 -15	16 42	+16 0	-16 -26	25 75	+25 0	-25 -50	35 115	+40 0	-35 -75

Tolerance limits given in body of table are added or subtracted to basic size (as indicated by + or - sign) to obtain maximum and minimum sizes of mating parts.

All data above heavy lines are in accordance with American-British-Canadian (ABC) agreements. Symbols H6, H7, s6, etc. are hole and shaft designations in ABC system. Limits for sizes above 19.69 inches are not covered by ABC agreements but are given in the ANSI Standard.

Table 7. ANSI Standard Transition Locational Fits ANSI B4.1-1967 (R1987)

Nominal Size Range, Inches	Class LT 1			Class LT 2			Class LT 3			Class LT 4			Class LT 5			Class LT 6								
	Fit ^a	Std. Tolerance Limits		Fit ^a	Std. Tolerance Limits		Fit ^a	Std. Tolerance Limits		Fit ^a	Std. Tolerance Limits		Fit ^a	Std. Tolerance Limits		Fit ^a	Std. Tolerance Limits							
		Hole H7	Shaft js6		Hole H8	Shaft js7		Hole H7	Shaft k6		Hole H8	Shaft k7		Hole H7	Shaft n6		Hole H7	Shaft n7						
	Over	Values shown below are in thousandths of an inch																	To					
0 – 0.12	-0.12 +0.52	+0.4 0	+0.12 -0.12	-0.2 +0.8	+0.6 0	+0.2 -0.2													-0.5 +0.15	+0.4 0	+0.5 +0.25	-0.65 +0.15	+0.4 0	+0.65 +0.25
0.12 – 0.24	-0.15 +0.65	+0.5 0	+0.15 -0.15	-0.25 +0.95	+0.7 0	+0.25 -0.25													-0.6 +0.2	+0.5 0	+0.6 +0.3	-0.8 +0.2	+0.5 0	+0.8 +0.3
0.24 – 0.40	-0.2 +0.8	+0.6 0	+0.2 -0.2	-0.3 +1.2	+0.9 0	+0.3 -0.3	-0.5 +0.5	+0.6 0	+0.5 +0.1	-0.7 +0.8	+0.9 0	+0.7 +0.1	-0.8 +0.2	+0.6 0	+0.8 +0.4	-1.0 +0.2	+0.6 0	+0.8 +0.4	-0.8 +0.2	+0.5 0	+0.6 +0.3	-0.8 +0.2	+0.5 0	+0.8 +0.4
0.40 – 0.71	-0.2 +0.9	+0.7 0	+0.2 -0.2	-0.35 +1.35	+1.0 0	+0.35 -0.35	-0.5 +0.6	+0.7 0	+0.5 +0.1	-0.8 +0.9	+1.0 0	+0.8 +0.1	-0.9 +0.2	+0.6 0	+0.9 +0.5	-1.2 +0.2	+0.7 0	+0.9 +0.5	-0.9 +0.2	+0.7 0	+0.9 +0.5	-1.2 +0.2	+0.7 0	+1.2 +0.5
0.71 – 1.19	-0.25 +1.05	+0.8 0	+0.25 -0.25	-0.4 +1.6	+1.2 0	+0.4 -0.4	-0.6 +0.7	+0.8 0	+0.6 +0.1	-0.9 +1.1	+1.2 0	+0.9 +0.1	-1.1 +0.2	+0.8 0	+1.1 +0.6	-1.4 +0.2	+0.8 0	+1.1 +0.6	-1.1 +0.2	+0.7 0	+1.1 +0.6	-1.4 +0.2	+0.8 0	+1.4 +0.6
1.19 – 1.97	-0.3 +1.3	+1.0 0	+0.3 -0.3	-0.5 +2.1	+1.6 0	+0.5 -0.5	-0.7 +0.9	+1.0 0	+0.7 +0.1	-1.1 +1.5	+1.6 0	+1.1 +0.1	-1.3 +0.3	+1.0 +0.7	+1.3 +0.3	-1.7 +0.3	+1.0 +0.7	+1.3 +0.3	-1.3 +0.3	+1.0 +0.7	+1.3 +0.3	-1.7 +0.3	+1.0 +0.7	+1.7 +0.7
1.97 – 3.15	-0.3 +1.5	+1.2 0	+0.3 -0.3	-0.6 +2.4	+1.8 0	+0.6 -0.6	-0.8 +1.1	+1.2 0	+0.8 +0.1	-1.3 +1.7	+1.8 0	+1.3 +0.1	-1.5 +0.4	+1.2 0	+1.5 +0.8	-2.0 +0.4	+1.2 0	+1.5 +0.8	-1.5 +0.4	+1.2 0	+1.5 +0.8	-2.0 +0.4	+1.2 0	+2.0 +0.8
3.15 – 4.73	-0.4 +1.8	+1.4 0	+0.4 -0.4	-0.7 +2.9	+2.2 0	+0.7 -0.7	-1.0 +1.3	+1.4 0	+1.0 +0.1	-1.5 +2.1	+2.2 0	+1.5 +0.1	-1.9 +0.4	+1.4 0	+1.9 +1.0	-2.4 +0.4	+1.4 0	+1.9 +1.0	-1.9 +0.4	+1.4 0	+1.9 +1.0	-2.4 +0.4	+1.4 0	+2.4 +1.0
4.73 – 7.09	-0.5 +2.1	+1.6 0	+0.5 -0.5	-0.8 +3.3	+2.5 0	+0.8 -0.8	-1.1 +1.5	+1.6 0	+1.1 +0.1	-1.7 +2.4	+2.5 0	+1.7 +0.1	-2.2 +0.4	+1.6 0	+2.2 +1.2	-2.8 +0.4	+1.6 0	+2.2 +1.2	-2.2 +0.4	+1.6 0	+2.2 +1.2	-2.8 +0.4	+1.6 0	+2.8 +1.2
7.09 – 9.85	-0.6 +2.4	+1.8 0	+0.6 -0.6	-0.9 +3.7	+2.8 0	+0.9 -0.9	-1.4 +1.6	+1.8 0	+1.4 +0.2	-2.0 +2.6	+2.8 0	+2.0 +0.2	-2.6 +0.4	+1.8 0	+2.6 +1.4	-3.2 +0.4	+1.8 0	+2.6 +1.4	-2.6 +0.4	+1.8 0	+2.6 +1.4	-3.2 +0.4	+1.8 0	+3.2 +1.4
9.85 – 12.41	-0.6 +2.6	+2.0 0	+0.6 -0.6	-1.0 +4.0	+3.0 0	+1.0 -1.0	-1.4 +1.8	+2.0 0	+1.4 +0.2	-2.2 +2.8	+3.0 0	+2.2 +0.2	-2.6 +0.6	+2.0 +1.4	+2.6 +1.4	-3.4 +0.6	+2.0 +1.4	+2.6 +1.4	-2.6 +0.6	+2.0 +1.4	+2.6 +1.4	-3.4 +0.6	+2.0 +1.4	+3.4 +1.4
12.41 – 15.75	-0.7 +2.9	+2.2 0	+0.7 -0.7	-1.0 +4.5	+3.5 0	+1.0 -1.0	-1.6 +2.0	+2.2 0	+1.6 +0.2	-2.4 +3.3	+3.5 0	+2.4 +0.2	-3.0 +0.6	+2.2 +1.6	+3.0 +1.6	-3.8 +0.6	+2.2 +1.6	+3.0 +1.6	-3.0 +0.6	+2.2 +1.6	+3.0 +1.6	-3.8 +0.6	+2.2 +1.6	+3.8 +1.6
15.75 – 19.69	-0.8 +3.3	+2.5 0	+0.8 -0.8	-1.2 +5.2	+4.0 0	+1.2 -1.2	-1.8 +2.3	+2.5 0	+1.8 +0.2	-2.7 +3.8	+4.0 0	+2.7 +0.2	-3.4 +0.7	+2.5 +1.8	+3.4 +1.8	-4.3 +0.7	+2.5 +1.8	+3.4 +1.8	-3.4 +0.7	+2.5 +1.8	+3.4 +1.8	-4.3 +0.7	+2.5 +1.8	+4.3 +1.8

^aPairs of values shown represent maximum amount of interference (-) and maximum amount of clearance (+) resulting from application of standard tolerance limits. All data above heavy lines are in accord with ABC agreements. Symbols H7, js6, etc., are hole and shaft designations in the ABC system.

Table 8. ANSI Standard Interference Location Fits ANSI B4.1-1967 (R1987)

Nominal Size Range, Inches	Class LN 1			Class LN 2			Class LN 3		
	Limits of Inter- ference	Standard Limits		Lim- its of Inter- ference	Standard Limits		Limits of Inter- ference	Standard Limits	
		Hole H6	Shaft n5		Hole H7	Shaft p6		Hole H7	Shaft r6
Over To	Values shown below are given in thousandths of an inch								
0- 0.12	0	+0.25	+0.45	0	+0.4	+0.65	0.1	+0.4	+0.75
	0.45	0	+0.25	0.65	0	+0.4	0.75	0	+0.5
0.12- 0.24	0	+0.3	+0.5	0	+0.5	+0.8	0.1	+0.5	+0.9
	0.5	0	+0.3	0.8	0	+0.5	0.9	0	+0.6
0.24- 0.40	0	+0.4	+0.65	0	+0.6	+1.0	0.2	+0.6	+1.2
	0.65	0	+0.4	1.0	0	+0.6	1.2	0	+0.8
0.40- 0.71	0	+0.4	+0.8	0	+0.7	+1.1	0.3	+0.7	+1.4
	0.8	0	+0.4	1.1	0	+0.7	1.4	0	+1.0
0.71- 1.19	0	+0.5	+1.0	0	+0.8	+1.3	0.4	+0.8	+1.7
	1.0	0	+0.5	1.3	0	+0.8	1.7	0	+1.2
1.19- 1.97	0	+0.6	+1.1	0	+1.0	+1.6	0.4	+1.0	+2.0
	1.1	0	+0.6	1.6	0	+1.0	2.0	0	+1.4
1.97- 3.15	0.1	+0.7	+1.3	0.2	+1.2	+2.1	0.4	+1.2	+2.3
	1.3	0	+0.8	2.1	0	+1.4	2.3	0	+1.6
3.15- 4.73	0.1	+0.9	+1.6	0.2	+1.4	+2.5	0.6	+1.4	+2.9
	1.6	0	+1.0	2.5	0	+1.6	2.9	0	+2.0
4.73- 7.09	0.2	+1.0	+1.9	0.2	+1.6	+2.8	0.9	+1.6	+3.5
	1.9	0	+1.2	2.8	0	+1.8	3.5	0	+2.5
7.09- 9.85	0.2	+1.2	+2.2	0.2	+1.8	+3.2	1.2	+1.8	+4.2
	2.2	0	+1.4	3.2	0	+2.0	4.2	0	+3.0
9.85- 12.41	0.2	+1.2	+2.3	0.2	+2.0	+3.4	1.5	+2.0	+4.7
	2.3	0	+1.4	3.4	0	+2.2	4.7	0	+3.5
12.41- 15.75	0.2	+1.4	+2.6	0.3	+2.2	+3.9	2.3	+2.2	+5.9
	2.6	0	+1.6	3.9	0	+2.5	5.9	0	+4.5
15.75- 19.69	0.2	+1.6	+2.8	0.3	+2.5	+4.4	2.5	+2.5	+6.6
	2.8	0	+1.8	4.4	0	+2.8	6.6	0	+5.0

All data in this table are in accordance with American-British-Canadian (ABC) agreements.

Limits for sizes above 19.69 inches are not covered by ABC agreements but are given in the ANSI Standard.

Symbols H7, p6, etc., are hole and shaft designations in the ABC system.

Tolerance limits given in body of table are added or subtracted to basic size (as indicated by + or - sign) to obtain maximum and minimum sizes of mating parts.

Table 9. ANSI Standard Force and Shrink Fits ANSI B4.1-1967 (R1987)

Nominal Size Range, Inches	Class FN 1			Class FN 2			Class FN 3			Class FN 4			Class FN 5		
	Inter- ference ^a	Standard Tolerance Limits		Inter- ference ^a	Standard Tolerance Limits		Inter- ference ^a	Standard Tolerance Limits		Inter- ference ^a	Standard Tolerance Limits		Inter- ference ^a	Standard Tolerance Limits	
		Hole H6	Shaft		Hole H7	Shaft s6		Hole H7	Shaft t6		Hole H7	Shaft u6		Hole H8	Shaft x7
Over To	Values shown below are in thousandths of an inch														
0- 0.12	0.05 0.5	+0.25 0	+0.5 +0.3	0.2 0.85	+0.4 0	+0.85 +0.6				0.3 0.95	+0.4 +0.7	+0.95 +0.7	0.3 1.3	+0.6 0	+1.3 +0.9
0.12- 0.24	0.1 0.6	+0.3 0	+0.6 +0.4	0.2 1.0	+0.5 0	+1.0 +0.7				0.4 1.2	+0.5 +0.9	+1.2 +0.9	0.5 1.7	+0.7 0	+1.7 +1.2
0.24- 0.40	0.1 0.75	+0.4 0	+0.75 +0.5	0.4 1.4	+0.6 0	+1.4 +1.0				0.6 1.6	+0.6 +1.2	+1.6 +1.2	0.5 2.0	+0.9 0	+2.0 +1.4
0.40- 0.56	0.1 0.8	+0.4 0	+0.8 +0.5	0.5 1.6	+0.7 0	+1.6 +1.2				0.7 1.8	+0.7 +1.4	+1.8 +1.4	0.6 2.3	+1.0 0	+2.3 +1.6
0.56- 0.71	0.2 0.9	+0.4 0	+0.9 +0.6	0.5 1.6	+0.7 0	+1.6 +1.2				0.7 1.8	+0.7 +1.4	+1.8 +1.4	0.8 2.5	+1.0 0	+2.5 +1.8
0.71- 0.95	0.2 1.1	+0.5 0	+1.1 +0.7	0.6 1.9	+0.8 0	+1.9 +1.4				0.8 2.1	+0.8 +1.6	+2.1 +1.6	1.0 3.0	+1.2 0	+3.0 +2.2
0.95- 1.19	0.3 1.2	+0.5 0	+1.2 +0.8	0.6 1.9	+0.8 0	+1.9 +1.4	0.8 2.1	+0.8 0	+2.1 +1.6	+1.0 2.3	+0.8 +1.8	+2.3 +1.8	1.3 3.3	+1.2 0	+3.3 +2.5
1.19- 1.58	0.3 1.3	+0.6 0	+1.3 +0.9	0.8 2.4	+1.0 0	+2.4 +1.8	1.0 2.6	+1.0 0	+2.6 +2.0	1.5 3.1	+1.0 +2.5	+3.1 +2.5	1.4 4.0	+1.6 0	+4.0 +3.0
1.58- 1.97	0.4 1.4	+0.6 0	+1.4 +1.0	0.8 2.4	+1.0 0	+2.4 +1.8	1.2 2.8	+1.0 0	+2.8 +2.2	1.8 3.4	+1.0 +2.8	+3.4 +2.8	2.4 5.0	+1.6 0	+5.0 +4.0
1.97- 2.56	0.6 1.8	+0.7 0	+1.8 +1.3	0.8 2.7	+1.2 0	+2.7 +2.0	1.3 3.2	+1.2 0	+3.2 +2.5	2.3 4.2	+1.2 +3.5	+4.2 +3.5	3.2 6.2	+1.8 0	+6.2 +5.0
2.56- 3.15	0.7 1.9	+0.7 0	+1.9 +1.4	1.0 2.9	+1.2 0	+2.9 +2.2	1.8 3.7	+1.2 0	+3.7 +3.0	2.8 4.7	+1.2 +4.0	+4.7 +4.0	4.2 7.2	+1.8 0	+7.2 +6.0
3.15- 3.94	0.9 2.4	+0.9 0	+2.4 +1.8	1.4 3.7	+1.4 0	+3.7 +2.8	2.1 4.4	+1.4 0	+4.4 +3.5	3.6 5.9	+1.4 +5.0	+5.9 +5.0	4.8 8.4	+2.2 0	+8.4 +7.0
3.94- 4.73	1.1 2.6	+0.9 0	+2.6 +2.0	1.6 3.9	+1.4 0	+3.9 +3.0	2.6 4.9	+1.4 0	+4.9 +4.0	4.6 6.9	+1.4 +6.0	+6.9 +6.0	5.8 9.4	+2.2 0	+9.4 +8.0

Table 9. (Continued) ANSI Standard Force and Shrink Fits ANSI B4.1-1967 (R1987)

Nominal Size Range, Inches		Class FN 1			Class FN 2			Class FN 3			Class FN 4			Class FN 5		
		Inter- ference ^a	Standard Tolerance Limits		Inter- ference ^a	Standard Tolerance Limits		Inter- ference ^a	Standard Tolerance Limits		Inter- ference ^a	Standard Tolerance Limits		Inter- ference ^a	Standard Tolerance Limits	
			Hole H6	Shaft		Hole H7	Shaft s6		Hole H7	Shaft t6		Hole H7	Shaft u6		Hole H8	Shaft x7
Over	To	Values shown below are in thousandths of an inch														
4.73–	5.52	1.2 2.9	+1.0 0	+2.9 +2.2	1.9 4.5	+1.6 0	+4.5 +3.5	3.4 6.0	+1.6 0	+6.0 +5.0	5.4 8.0	+1.6 0	+8.0 +7.0	7.5 11.6	+2.5 0	+11.6 +10.0
5.52–	6.30	1.5 3.2	+1.0 0	+3.2 +2.5	2.4 5.0	+1.6 0	+5.0 +4.0	3.4 6.0	+1.6 0	+6.0 +5.0	5.4 8.0	+1.6 0	+8.0 +7.0	9.5 13.6	+2.5 0	+13.6 +12.0
6.30–	7.09	1.8 3.5	+1.0 0	+3.5 +2.8	2.9 5.5	+1.6 0	+5.5 +4.5	4.4 7.0	+1.6 0	+7.0 +6.0	6.4 9.0	+1.6 0	+9.0 +8.0	9.5 13.6	+2.5 0	+13.6 +12.0
7.09–	7.88	1.8 3.8	+1.2 0	+3.8 +3.0	3.2 6.2	+1.8 0	+6.2 +5.0	5.2 8.2	+1.8 0	+8.2 +7.0	7.2 10.2	+1.8 0	+10.2 +9.0	11.2 15.8	+2.8 0	+15.8 +14.0
7.88–	8.86	2.3 4.3	+1.2 0	+4.3 +3.5	3.2 6.2	+1.8 0	+6.2 +5.0	5.2 8.2	+1.8 0	+8.2 +7.0	8.2 11.2	+1.8 0	+11.2 +10.0	13.2 17.8	+2.8 0	+17.8 +16.0
8.86–	9.85	2.3 4.3	+1.2 0	+4.3 +3.5	4.2 7.2	+1.8 0	+7.2 +6.0	6.2 9.2	+1.8 0	+9.2 +8.0	10.2 13.2	+1.8 0	+13.2 +12.0	13.2 17.8	+2.8 0	+17.8 +16.0
9.85–	11.03	2.8 4.9	+1.2 0	+4.9 +4.0	4.0 7.2	+2.0 0	+7.2 +6.0	7.0 10.2	+2.0 0	+10.2 +9.0	10.0 13.2	+2.0 0	+13.2 +12.0	15.0 20.0	+3.0 0	+20.0 +18.0
11.03–	12.41	2.8 4.9	+1.2 0	+4.9 +4.0	5.0 8.2	+2.0 0	+8.2 +7.0	7.0 10.2	+2.0 0	+10.2 +9.0	12.0 15.2	+2.0 0	+15.2 +14.0	17.0 22.0	+3.0 0	+22.0 +20.0
12.41–	13.98	3.1 5.5	+1.4 0	+5.5 +4.5	5.8 9.4	+2.2 0	+9.4 +8.0	7.8 11.4	+2.2 0	+11.4 +10.0	13.8 17.4	+2.2 0	+17.4 +16.0	18.5 24.2	+3.5 0	+24.2 +22.0
13.98–	15.75	3.6 6.1	+1.4 0	+6.1 +5.0	5.8 9.4	+2.2 0	+9.4 +8.0	9.8 13.4	+2.2 0	+13.4 +12.0	15.8 19.4	+2.2 0	+19.4 +18.0	21.5 27.2	+3.5 0	+27.2 +25.0
15.75–	17.72	4.4 7.0	+1.6 0	+7.0 +6.0	6.5 10.6	+2.5 0	+10.6 +9.0	9.5 13.6	+2.5 0	+13.6 +12.0	17.5 21.6	+2.5 0	+21.6 +20.0	24.0 30.5	+4.0 0	+30.5 +28.0
17.72–	19.69	4.4 7.0	+1.6 0	+7.0 +6.0	7.5 11.6	+2.5 0	+11.6 +10.0	11.5 15.6	+2.5 0	+15.6 +14.0	19.5 23.6	+2.5 0	+23.6 +22.0	26.0 32.5	+4.0 0	+32.5 +30.0

^aPairs of values shown represent minimum and maximum amounts of interference resulting from application of standard tolerance limits.

All data above heavy lines are in accordance with American-British-Canadian (ABC) agreements. Symbols H6, H7, s6, etc., are hole and shaft designations in the ABC system. Limits for sizes above 19.69 inches are not covered by ABC agreements but are given in the ANSI standard.