

E27 Midterm Fall 2020 COVID-19 Edition

Questions 1-20 are to be answered in the bCourses Midterm quiz. Optional: If you have any concerns about how you interpreted any of the multiple choice questions that you didn't get answered during the exam, **please note them in box 23** (on the top of the first inside page of your free response template answer sheet). The last page of your free response template answer sheet is for your scratch work during the multiple choice section. Most questions won't require scratch work.

Short answer questions, to answer in fillable pdf:

21. (6 points) A mating shaft and hole have a nominal diameter of 1" (1 inch). You decide on an H7/h6 fit. Using the tables from Machinery's Handbook at the end of this file, answer the following questions for this fit in the fillable pdf answer sheet:
- What is the smallest acceptable clearance, in inches (or say NA if smallest is interference)?**
 - What is the largest acceptable clearance, in inches (or say NA if largest is interference)?**
 - What is the smallest acceptable interference, in inches (or say NA if smallest is clearance)?**
 - What is the largest acceptable interference, in inches (or say NA if largest is clearance)?**
 - What is the smallest acceptable hole size, in inches?**
 - What is the largest acceptable hole size, in inches?**
 - What is the smallest acceptable shaft size, in inches?**
 - What is the largest acceptable shaft size, in inches?**
22. (3 pts) **Why is an interference fit between a tool holder (collet) and an end mill at room temperature necessary for machining?**
Type your answer directly into the fillable pdf answer sheet. We expect the best answers to be only ~1 sentence.

Free Response Questions (answer in Free Response Answer Sheet Template & also put final answers into the Fillable PDF Answer Sheet)

23. Optional: If you have any concerns about how you interpreted any of the multiple choice questions that you didn't get answered during the exam, please note them in the box for this question.

24. (6 points) You machine a 100mm-long cylindrical part from round stock with a diameter of 90 mm down to a diameter of 80 mm on a lathe in 4 passes using a speed of 900 rpm. It takes one minute to machine the part. **Calculate your material removal rate for machining this part.** Show your work. **Put your final answer in the answer box at the bottom right of the larger rectangle for this problem on your free response template.** In addition, **type in your final answer into the fillable pdf.**

25. (10 points) You are planning to use an end mill made out of steel with a shank diameter of 30.000 mm (at 20 degrees C). The tool holder (collet) is also made out of steel. (Assume the coefficient of thermal expansion for this steel is $\alpha=12 \times 10^{-6}/K$.)

At room temperature (20 degrees C), the tool holder (collet) and milling tool (shank) need to have a 0.055 mm interference fit.

a) **What type of fit is this? Give both the English name from the table and the corresponding ISO hole and shaft codes in the format H?/? or ?/?/h? (replace the ?s) as appropriate (from the same table).** Clearly label your answer as “a” and hand-draw a box around the “a” and your answer.

Note: Tables from Machinery’s Handbook are provided at the end of this document.

b) **In order to have an interference fit of 0.055 mm at room temperature, what will the inner diameter of the tool holder need to be at room temperature?** Show your work. Remember the milling tool has a diameter of 30.000 mm at room temperature. Clearly label your answer as “b” and hand-draw a box around the “b” and your answer.

You determine that for ease of assembly the tool holder (collet) and milling tool (shank) need to have a clearance of 0.03 mm when putting the assembly together.

c) **What temperature does the tool holder need to be at in order to achieve this clearance fit?** Show your work. **Put your final answer in the answer box at the bottom right of the larger rectangle for this problem on your free response template.** In addition, **type in your final answer to part c) on the fillable pdf.** (Remember alpha for this steel is $12 \times 10^{-6}/K$.)

26. (6 points) You are machining a part on a manual lathe and analyzing forces using the orthogonal cutting model. Your process has a cutting force of 3,000 N and a thrust force of 400 N. The rake angle of the tool is 30 degrees.
- Find the total reaction force (R).** Show your work. Clearly **label your answer as “a)”** and **hand-draw a box around the “a)”** and your answer.
 - Find the **frictional force (F) in the plane of the rake face of the tool (F)**. Show your work. **Put your final answer in the answer box at the bottom right of the larger rectangle for this problem on your free response template.** In addition, **type in your final answer to part b) on the fillable pdf.** (Hint: trigonometry will be useful, as well as what you learned in this course. And yes, we gave you all the information you need. :))
27. Sheet for your scratch work during the multiple choice section. Most questions won't require scratch work. You can attach additional blank sheets for scratch work if applicable.

Machinery's Handbook Tables

Machinery's Handbook 30th Edition

Table 2. American National Standard Preferred Hole Basis Metric Clearance Fits ASME B4.2-1978 (R2009)

Basic Size ^a		Loose Running			Free Running			Close Running			Sliding			Locational Clearance		
		Hole H11	Shaft c11	Fit ^b	Hole H9	Shaft d9	Fit ^b	Hole H8	Shaft f7	Fit ^b	Hole H7	Shaft g6	Fit ^b	Hole H7	Shaft h6	Fit ^b
1	Max	1.060	0.940	0.180	1.025	0.980	0.070	1.014	0.994	0.030	1.010	0.998	0.018	1.010	1.000	0.016
	Min	1.000	0.880	0.060	1.000	0.995	0.020	1.000	0.984	0.006	1.000	0.992	0.002	1.000	0.994	0.000
1.2	Max	1.260	1.140	0.180	1.225	1.180	0.070	1.214	1.194	0.030	1.210	1.198	0.018	1.210	1.200	0.016
	Min	1.200	1.080	0.060	1.200	1.155	0.020	1.200	1.184	0.006	1.200	1.192	0.002	1.200	1.194	0.000
1.6	Max	1.660	1.540	0.180	1.625	1.580	0.070	1.614	1.594	0.030	1.610	1.598	0.018	1.610	1.600	0.016
	Min	1.600	1.480	0.060	1.600	1.555	0.020	1.600	1.584	0.006	1.600	1.592	0.002	1.600	1.594	0.000
2	Max	2.060	1.940	0.180	2.025	1.980	0.070	2.014	1.994	0.030	2.010	1.998	0.018	2.010	2.000	0.016
	Min	2.000	1.880	0.060	2.000	1.955	0.020	2.000	1.984	0.006	2.000	1.992	0.002	2.000	1.994	0.000
2.5	Max	2.560	2.440	0.180	2.525	2.480	0.070	2.514	2.494	0.030	2.510	2.498	0.018	2.510	2.500	0.016
	Min	2.500	2.380	0.060	2.500	2.455	0.020	2.500	2.484	0.006	2.500	2.492	0.002	2.500	2.494	0.000
3	Max	3.060	2.940	0.180	3.025	2.980	0.070	3.014	2.994	0.030	3.010	2.998	0.018	3.010	3.000	0.016
	Min	3.000	2.880	0.060	3.000	2.955	0.020	3.000	2.984	0.006	3.000	2.992	0.002	3.000	2.994	0.000
4	Max	4.075	3.930	0.220	4.030	3.970	0.090	4.018	3.990	0.040	4.012	3.996	0.024	4.012	4.000	0.020
	Min	4.000	3.855	0.070	4.000	3.940	0.030	4.000	3.978	0.010	4.000	3.988	0.004	4.000	3.992	0.000
5	Max	5.075	4.930	0.220	5.030	4.970	0.090	5.018	4.990	0.040	5.012	4.996	0.024	5.012	5.000	0.020
	Min	5.000	4.855	0.070	5.000	4.940	0.030	5.000	4.978	0.010	5.000	4.988	0.004	5.000	4.992	0.000
6	Max	6.075	5.930	0.220	6.030	5.970	0.090	6.018	5.990	0.040	6.012	5.996	0.024	6.012	6.000	0.020
	Min	6.000	5.855	0.070	6.000	5.940	0.030	6.000	5.978	0.010	6.000	5.988	0.004	6.000	5.992	0.000
8	Max	8.090	7.920	0.260	8.036	7.960	0.112	8.022	7.987	0.050	8.015	7.995	0.029	8.015	8.000	0.024
	Min	8.000	7.830	0.080	8.000	7.924	0.040	8.000	7.972	0.013	8.000	7.986	0.005	8.000	7.991	0.000
10	Max	10.090	9.920	0.260	10.036	9.960	0.112	10.022	9.987	0.050	10.015	9.995	0.029	10.015	10.000	0.024
	Min	10.000	9.830	0.080	10.000	9.924	0.040	10.000	9.972	0.013	10.000	9.986	0.005	10.000	9.991	0.000
12	Max	12.110	11.905	0.315	12.043	11.956	0.136	12.027	11.984	0.061	12.018	11.994	0.035	12.018	12.000	0.029
	Min	12.000	11.795	0.095	12.000	11.907	0.050	12.000	11.966	0.016	12.000	11.983	0.006	12.000	11.989	0.000
16	Max	16.110	15.905	0.315	16.043	15.950	0.136	16.027	15.984	0.061	16.018	15.994	0.035	16.018	16.000	0.029
	Min	16.000	15.795	0.095	16.000	15.907	0.050	16.000	15.966	0.016	16.000	15.983	0.006	16.000	15.989	0.000
20	Max	20.130	19.890	0.370	20.052	19.935	0.169	20.033	19.980	0.074	20.021	19.993	0.041	20.021	20.000	0.034
	Min	20.000	19.760	0.110	20.000	19.883	0.065	20.000	19.959	0.020	20.000	19.980	0.007	20.000	19.987	0.000
25	Max	25.130	24.890	0.370	25.052	24.935	0.169	25.033	24.980	0.074	25.021	24.993	0.041	25.021	25.000	0.034
	Min	25.000	24.760	0.110	25.000	24.883	0.065	25.000	24.959	0.020	25.000	24.980	0.007	25.000	24.987	0.000

Table 2. (Continued) American National Standard Preferred Hole Basis Metric Clearance Fits ASME B4.2-1978 (R2009)

Basic Size ^a		Loose Running			Free Running			Close Running			Sliding			Locational Clearance		
		Hole H11	Shaft c11	Fit ^b	Hole H9	Shaft d9	Fit ^b	Hole H8	Shaft f7	Fit ^b	Hole H7	Shaft g6	Fit ^b	Hole H7	Shaft h6	Fit ^b
30	Max	30.130	29.890	0.370	30.052	29.935	0.169	30.033	29.980	0.074	30.021	29.993	0.041	30.021	30.000	0.034
	Min	30.000	29.760	0.110	30.000	29.883	0.065	30.000	29.959	0.020	30.000	29.980	0.007	30.000	29.987	0.000
40	Max	40.160	39.880	0.440	40.062	39.920	0.204	40.039	39.975	0.089	40.025	39.991	0.050	40.025	40.000	0.041
	Min	40.000	39.720	0.120	40.000	39.858	0.080	40.000	39.950	0.025	40.000	39.975	0.009	40.000	39.984	0.000
50	Max	50.160	49.870	0.450	50.062	49.920	0.204	50.039	49.975	0.089	50.025	49.991	0.050	50.025	50.000	0.041
	Min	50.000	49.710	0.130	50.000	49.858	0.080	50.000	49.950	0.025	50.000	49.975	0.009	50.000	49.984	0.000
60	Max	60.190	59.860	0.520	60.074	59.900	0.248	60.046	59.970	0.106	60.030	59.990	0.059	60.030	60.000	0.049
	Min	60.000	59.670	0.140	60.000	59.826	0.100	60.000	59.940	0.030	60.000	59.971	0.010	60.000	59.981	0.000
80	Max	80.190	79.850	0.530	80.074	79.900	0.248	80.046	79.970	0.106	80.030	79.990	0.059	80.030	80.000	0.049
	Min	80.000	79.660	0.150	80.000	79.826	0.100	80.000	79.940	0.030	80.000	79.971	0.010	80.000	79.981	0.000
100	Max	100.220	99.830	0.610	100.087	99.880	0.294	100.054	99.964	0.125	100.035	99.988	0.069	100.035	100.000	0.057
	Min	100.000	99.610	0.170	100.000	99.793	0.120	100.000	99.929	0.036	100.000	99.966	0.012	100.000	99.978	0.000
120	Max	120.220	119.820	0.620	120.087	119.880	0.294	120.054	119.964	0.125	120.035	119.988	0.069	120.035	120.000	0.057
	Min	120.000	119.600	0.180	120.000	119.793	0.120	120.000	119.929	0.036	120.000	119.966	0.012	120.000	119.978	0.000
160	Max	160.250	159.790	0.710	160.100	159.855	0.345	160.063	159.957	0.146	160.040	159.986	0.079	160.040	160.000	0.065
	Min	160.000	159.540	0.210	160.000	159.755	0.145	160.000	159.917	0.043	160.000	159.961	0.014	160.000	159.975	0.000
200	Max	200.290	199.760	0.820	200.115	199.830	0.400	200.072	199.950	0.168	200.046	199.985	0.090	200.046	200.000	0.075
	Min	200.000	199.470	0.240	200.000	199.715	0.170	200.000	199.904	0.050	200.000	199.956	0.015	200.000	199.971	0.000
250	Max	250.290	249.720	0.860	250.115	249.830	0.400	250.072	249.950	0.168	250.046	249.985	0.090	250.046	250.000	0.075
	Min	250.000	249.430	0.280	250.000	249.715	0.170	250.000	249.904	0.050	250.000	249.956	0.015	250.000	249.971	0.000
300	Max	300.320	299.670	0.970	300.130	299.810	0.450	300.081	299.944	0.189	300.052	299.983	0.101	300.052	300.000	0.084
	Min	300.000	299.350	0.330	300.000	299.680	0.190	300.000	299.892	0.056	300.000	299.951	0.017	300.000	299.968	0.000
400	Max	400.360	399.600	1.120	400.140	399.790	0.490	400.089	399.938	0.208	400.057	399.982	0.111	400.057	400.000	0.093
	Min	400.000	399.240	0.400	400.000	399.650	0.210	400.000	399.881	0.062	400.000	399.946	0.018	400.000	399.964	0.000
500	Max	500.400	499.520	1.280	500.155	499.770	0.540	500.097	499.932	0.228	500.063	499.980	0.123	500.063	500.000	0.103
	Min	500.000	499.120	0.480	500.000	499.615	0.230	500.000	499.869	0.068	500.000	499.940	0.020	500.000	499.960	0.000

^a The sizes shown are first-choice basic sizes (see Table 1, page 662). Preferred fits for other sizes can be calculated from data given in ASME B4.2-1978 (R2009).

^b All fits shown in this table have clearance. All dimensions are in millimeters.

Table 4. American National Standard Preferred Shaft Basis Metric Clearance Fits ASME B4.2-1978 (R2009)

Basic Size ^a	Loose Running			Free Running			Close Running			Sliding			Locational Clearance			
		Hole C11	Shaft h11	Fit ^b	Hole D9	Shaft h9	Fit ^b	Hole F8	Shaft h7	Fit ^b	Hole G7	Shaft h6	Fit ^b	Hole H7	Shaft h6	Fit ^b
		Max	Min		Max	Min		Max	Min		Max	Min		Max	Min	
1	Max	1.120	1.000	0.180	1.045	1.000	0.070	1.020	1.000	0.030	1.012	1.000	0.018	1.010	1.000	0.016
	Min	1.060	0.940	0.060	1.020	0.975	0.020	1.006	0.990	0.006	1.002	0.994	0.002	1.000	0.994	0.000
1.2	Max	1.320	1.200	0.180	1.245	1.200	0.070	1.220	1.200	0.030	1.212	1.200	0.018	1.210	1.200	0.016
	Min	1.260	1.140	0.060	1.220	1.175	0.020	1.206	1.190	0.006	1.202	1.194	0.002	1.200	1.194	0.000
1.6	Max	1.720	1.600	0.180	1.645	1.600	0.070	1.620	1.600	0.030	1.612	1.600	0.018	1.610	1.600	0.016
	Min	1.660	1.540	0.060	1.620	1.575	0.020	1.606	1.590	0.006	1.602	1.594	0.002	1.600	1.594	0.000
2	Max	2.120	2.000	0.180	2.045	2.000	0.070	2.020	2.000	0.030	2.012	2.000	0.018	2.010	2.000	0.016
	Min	2.060	1.940	0.060	2.020	1.975	0.020	2.006	1.990	0.006	2.002	1.994	0.002	2.000	1.994	0.000
2.5	Max	2.620	2.500	0.180	2.545	2.500	0.070	2.520	2.500	0.030	2.512	2.500	0.018	2.510	2.500	0.016
	Min	2.560	2.440	0.060	2.520	2.475	0.020	2.506	2.490	0.006	2.502	2.494	0.002	2.500	2.494	0.000
3	Max	3.120	3.000	0.180	3.045	3.000	0.070	3.020	3.000	0.030	3.012	3.000	0.018	3.010	3.000	0.016
	Min	3.060	2.940	0.060	3.020	2.975	0.020	3.006	2.990	0.006	3.002	2.994	0.002	3.000	2.994	0.000
4	Max	4.145	4.000	0.220	4.060	4.000	0.090	4.028	4.000	0.040	4.016	4.000	0.024	4.012	4.000	0.020
	Min	4.070	3.925	0.070	4.030	3.970	0.030	4.010	3.988	0.010	4.004	3.992	0.004	4.000	3.992	0.000
5	Max	5.145	5.000	0.220	5.060	5.000	0.090	5.028	5.000	0.040	5.016	5.000	0.024	5.012	5.000	0.020
	Min	5.070	4.925	0.070	5.030	4.970	0.030	5.010	4.988	0.010	5.004	4.992	0.004	5.000	4.992	0.000
6	Max	6.145	6.000	0.220	6.060	6.000	0.090	6.028	6.000	0.040	6.016	6.000	0.024	6.012	6.000	0.020
	Min	6.070	5.925	0.070	6.030	5.970	0.030	6.010	5.988	0.010	6.004	5.992	0.004	6.000	5.992	0.000
8	Max	8.170	8.000	0.260	8.076	8.000	0.112	8.035	8.000	0.050	8.020	8.000	0.029	8.015	8.000	0.024
	Min	8.080	7.910	0.080	8.040	7.964	0.040	8.013	7.985	0.013	8.005	7.991	0.005	8.000	7.991	0.000
10	Max	10.170	10.000	0.260	10.076	10.000	0.112	10.035	10.000	0.050	10.020	10.000	0.029	10.015	10.000	0.024
	Min	10.080	9.910	0.080	10.040	9.964	0.040	10.013	9.985	0.013	10.005	9.991	0.005	10.000	9.991	0.000
12	Max	12.205	12.000	0.315	12.093	12.000	0.136	12.043	12.000	0.061	12.024	12.000	0.035	12.018	12.000	0.029
	Min	12.095	11.890	0.095	12.050	11.957	0.050	12.016	11.982	0.016	12.006	11.989	0.006	12.000	11.989	0.000
16	Max	16.205	16.000	0.315	16.093	16.000	0.136	16.043	16.000	0.061	16.024	16.000	0.035	16.018	16.000	0.029
	Min	16.095	15.890	0.095	16.050	15.957	0.050	16.016	15.982	0.016	16.006	15.989	0.006	16.000	15.989	0.000
20	Max	20.240	20.000	0.370	20.117	20.000	0.169	20.053	20.000	0.074	20.028	20.000	0.041	20.021	20.000	0.034
	Min	20.110	19.870	0.110	20.065	19.948	0.065	20.020	19.979	0.020	20.007	19.987	0.007	20.000	19.987	0.000
25	Max	25.240	25.000	0.370	25.117	25.000	0.169	25.053	25.000	0.074	25.028	25.000	0.041	25.021	25.000	0.034
	Min	25.110	24.870	0.110	25.065	24.948	0.065	25.020	24.979	0.020	25.007	24.987	0.007	25.000	24.987	0.000

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<http://ebooks.industrialpress.com>**Table 3. (Continued) American National Standard Preferred Hole Basis Metric Transition and Interference Fits ASME B4.2-1978 (R2009)**

Basic Size ^a	Locational Transition			Locational Interference			Medium Drive			Force						
		Hole H7	Shaft k6	Fit ^b	Hole H7	Shaft n6	Fit ^b	Hole H7	Shaft p6	Fit ^b	Hole H7	Shaft s6	Fit ^b	Hole H7	Shaft u6	Fit ^b
		Max	Min		Max	Min		Max	Min		Max	Min		Max	Min	
30	Max	30.021	30.015	+0.019	30.021	30.028	+0.006	30.021	30.035	-0.001	30.021	30.048	-0.014	30.021	30.061	-0.027
	Min	30.000	30.002	-0.015	30.000	30.015	-0.028	30.000	30.022	-0.035	30.000	30.035	-0.048	30.000	30.048	-0.061
40	Max	40.025	40.018	+0.023	40.025	40.033	+0.008	40.025	40.042	-0.001	40.025	40.059	-0.018	40.025	40.076	-0.035
	Min	40.000	40.002	-0.018	40.000	40.017	-0.033	40.000	40.026	-0.042	40.000	40.043	-0.059	40.000	40.060	-0.076
50	Max	50.025	50.018	+0.023	50.025	50.033	+0.008	50.025	50.042	-0.001	50.025	50.059	-0.018	50.025	50.086	-0.045
	Min	50.000	50.002	-0.018	50.000	50.017	-0.033	50.000	50.026	-0.042	50.000	50.043	-0.059	50.000	50.070	-0.086
60	Max	60.030	60.021	+0.028	60.030	60.039	+0.010	60.030	60.051	-0.002	60.030	60.072	-0.023	60.030	60.106	-0.057
	Min	60.000	60.002	-0.021	60.000	60.020	-0.039	60.000	60.032	-0.051	60.000	60.053	-0.072	60.000	60.087	-0.106
80	Max	80.030	80.021	+0.028	80.030	80.039	+0.010	80.030	80.051	-0.002	80.030	80.078	-0.029	80.030	80.121	-0.072
	Min	80.000	80.002	-0.021	80.000	80.020	-0.039	80.000	80.032	-0.051	80.000	80.059	-0.078	80.000	80.102	-0.121
100	Max	100.035	100.025	+0.032	100.035	100.045	+0.012	100.035	100.059	-0.002	100.035	100.093	-0.036	100.035	100.146	-0.089
	Min	100.000	100.003	-0.025	100.000	100.023	-0.045	100.000	100.037	-0.059	100.000	100.071	-0.093	100.000	100.124	-0.146
120	Max	120.035	120.025	+0.032	120.035	120.045	+0.012	120.035	120.059	-0.002	120.035	120.101	-0.044	120.035	120.166	-0.109
	Min	120.000	120.003	-0.025	120.000	120.023	-0.045	120.000	120.037	-0.059	120.000	120.079	-0.101	120.000	120.144	-0.166
160	Max	160.040	160.028	+0.037	160.040	160.052	+0.013	160.040	160.068	-0.003	160.040	160.125	-0.060	160.040	160.215	-0.150
	Min	160.000	160.003	-0.028	160.000	160.027	-0.052	160.000	160.043	-0.068	160.000	160.100	-0.125	160.000	160.190	-0.215
200	Max	200.046	200.033	+0.042	200.046	200.060	+0.015	200.046	200.079	-0.004	200.046	200.151	-0.076	200.046	200.265	-0.190
	Min	200.000	200.004	-0.033	200.000	200.031	-0.060	200.000	200.050	-0.079	200.000	200.122	-0.151	200.000	200.236	-0.265
250	Max	250.046	250.033	+0.042	250.046	250.060	+0.015	250.046	250.079	-0.004	250.046	250.169	-0.094	250.046	250.313	-0.238
	Min	250.000	250.004	-0.033	250.000	250.031	-0.060	250.000	250.050	-0.079	250.000	250.140	-0.169	250.000	250.284	-0.313
300	Max	300.052	300.036	+0.048	300.052	300.066	+0.018	300.052	300.088	-0.004	300.052	300.202	-0.118	300.052	300.382	-0.298
	Min	300.000	300.004	-0.036	300.000	300.034	-0.066	300.000	300.056	-0.088	300.000	300.170	-0.202	300.000	300.350	-0.382
400	Max	400.057	400.040	+0.053	400.057	400.073	+0.020	400.057	400.098	-0.005	400.057	400.244	-0.151	400.057	400.471	-0.378
	Min	400.000	400.004	-0.040	400.000	400.037	-0.073	400.000	400.062	-0.098	400.000	400.208	-0.244	400.000	400.435	-0.471
500	Max	500.063	500.045	+0.058	500.063	500.080	+0.023	500.063	500.108	-0.005	500.063	500.292	-0.189	500.063	500.580	-0.477
	Min	500.000	500.005	-0.045	500.000	500.040	-0.080	500.000	500.068	-0.108	500.000	500.252	-0.292	500.000	500.540	-0.580

^a The sizes shown are first-choice basic sizes (see Table 1, page 662). Preferred fits for other sizes can be calculated from data given in ASME B4.2-1978 (R2009).^b A plus sign indicates clearance; a minus sign indicates interference.

All dimensions are in millimeters.

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Table 5. American National Standard Preferred Shaft Basis Metric Transition and Interference Fits ASME B4.2-1978 (R2009)

Basic Size ^a		Locational Transition			Locational Transition			Locational Interference			Medium Drive			Force		
		Hole K7	Shaft h6	Fit ^b	Hole N7	Shaft h6	Fit ^b	Hole P7	Shaft h6	Fit ^b	Hole S7	Shaft h6	Fit ^b	Hole U7	Shaft h6	Fit ^b
1	Max	1.000	1.000	+0.006	0.996	1.000	+0.002	0.994	1.000	0.000	0.986	1.000	-0.008	0.982	1.000	-0.012
	Min	0.990	0.994	-0.010	0.986	0.994	-0.014	0.984	0.994	-0.016	0.976	0.994	-0.024	0.972	0.994	-0.028
1.2	Max	1.200	1.200	+0.006	1.196	1.200	+0.002	1.194	1.200	0.000	1.186	1.200	-0.008	1.182	1.200	-0.012
	Min	1.190	1.194	-0.010	1.186	1.194	-0.014	1.184	1.194	-0.016	1.176	1.194	-0.024	1.172	1.194	-0.028
1.6	Max	1.600	1.600	+0.006	1.596	1.600	+0.002	1.594	1.600	0.000	1.586	1.600	-0.008	1.582	1.600	-0.012
	Min	1.590	1.594	-0.010	1.586	1.594	-0.014	1.584	1.594	-0.016	1.576	1.594	-0.024	1.572	1.594	-0.028
2	Max	2.000	2.000	+0.006	1.996	2.000	+0.002	1.994	2.000	0.000	1.986	2.000	-0.008	1.982	2.000	-0.012
	Min	1.990	1.994	-0.010	1.986	1.994	-0.014	1.984	1.994	-0.016	1.976	1.994	-0.024	1.972	1.994	-0.028
2.5	Max	2.500	2.500	+0.006	2.496	2.500	+0.002	2.494	2.500	0.000	2.486	2.500	-0.008	2.482	2.500	-0.012
	Min	2.490	2.494	-0.010	2.486	2.494	-0.014	2.484	2.494	-0.016	2.476	2.494	-0.024	2.472	2.494	-0.028
3	Max	3.000	3.000	+0.006	2.996	3.000	+0.002	2.994	3.000	0.000	2.986	3.000	-0.008	2.982	3.000	-0.012
	Min	2.990	2.994	-0.010	2.986	2.994	-0.014	2.984	2.994	-0.016	2.976	2.994	-0.024	2.972	2.994	-0.028
4	Max	4.003	4.000	+0.011	3.996	4.000	+0.004	3.992	4.000	0.000	3.985	4.000	-0.007	3.981	4.000	-0.011
	Min	3.991	3.992	-0.009	3.984	3.992	-0.016	3.980	3.992	-0.020	3.973	3.992	-0.027	3.969	3.992	-0.031
5	Max	5.003	5.000	+0.011	4.996	5.000	+0.004	4.992	5.000	0.000	4.985	5.000	-0.007	4.981	5.000	-0.011
	Min	4.991	4.992	-0.009	4.984	4.992	-0.016	4.980	4.992	-0.020	4.973	4.992	-0.027	4.969	4.992	-0.031
6	Max	6.003	6.000	+0.011	5.996	6.000	+0.004	5.992	6.000	0.000	5.985	6.000	-0.007	5.981	6.000	-0.011
	Min	5.991	5.992	-0.009	5.984	5.992	-0.016	5.980	5.992	-0.020	5.973	5.992	-0.027	5.969	5.992	-0.031
8	Max	8.005	8.000	+0.014	7.996	8.000	+0.005	7.991	8.000	0.000	7.983	8.000	-0.008	7.978	8.000	-0.013
	Min	7.990	7.991	-0.010	7.981	7.991	-0.019	7.976	7.991	-0.024	7.968	7.991	-0.032	7.963	7.991	-0.037
10	Max	10.005	10.000	+0.014	9.996	10.000	+0.005	9.991	10.000	0.000	9.983	10.000	-0.008	9.978	10.000	-0.013
	Min	9.990	9.991	-0.010	9.981	9.991	-0.019	9.976	9.991	-0.024	9.968	9.991	-0.032	9.963	9.991	-0.037
12	Max	12.006	12.000	+0.017	11.995	12.000	+0.006	11.989	12.000	0.000	11.979	12.000	-0.010	11.974	12.000	-0.015
	Min	11.988	11.989	-0.012	11.977	11.989	-0.023	11.971	11.989	-0.029	11.961	11.989	-0.039	11.956	11.989	-0.044
16	Max	16.006	16.000	+0.017	15.995	16.000	+0.006	15.989	16.000	0.000	15.979	16.000	-0.010	15.974	16.000	-0.015
	Min	15.988	15.989	-0.012	15.977	15.989	-0.023	15.971	15.989	-0.029	15.961	15.989	-0.039	15.956	15.989	-0.044
20	Max	20.006	20.000	+0.019	19.993	20.000	+0.006	19.986	20.000	-0.001	19.973	20.000	-0.014	19.967	20.000	-0.020
	Min	19.985	19.987	-0.015	19.972	19.987	-0.028	19.965	19.987	-0.035	19.952	19.987	-0.048	19.946	19.987	-0.054
25	Max	25.006	25.000	+0.019	24.993	25.000	+0.006	24.986	25.000	-0.001	24.973	25.000	-0.014	24.966	25.000	-0.027
	Min	24.985	24.987	-0.015	24.972	24.987	-0.028	24.965	24.987	-0.035	24.952	24.987	-0.048	24.939	24.987	-0.061

Table 5. (Continued) American National Standard Preferred Shaft Basis Metric Transition and Interference Fits ASME B4.2-1978 (R2009)

Basic Size ^a		Locational Transition			Locational Transition			Locational Interference			Medium Drive			Force		
		Hole K7	Shaft h6	Fit ^b	Hole N7	Shaft h6	Fit ^b	Hole P7	Shaft h6	Fit ^b	Hole S7	Shaft h6	Fit ^b	Hole U7	Shaft h6	Fit ^b
30	Max	30.006	30.000	+0.019	29.993	30.000	+0.006	29.986	30.000	-0.001	29.973	30.000	-0.014	29.960	30.000	-0.027
	Min	29.985	29.987	-0.015	29.972	29.987	-0.028	29.965	29.987	-0.035	29.952	29.987	-0.048	29.939	29.987	-0.061
40	Max	40.007	40.000	+0.023	39.992	40.000	+0.008	39.983	40.000	-0.001	39.966	40.000	-0.018	39.949	40.000	-0.035
	Min	39.982	39.984	-0.018	39.967	39.984	-0.033	39.958	39.984	-0.042	39.941	39.984	-0.059	39.924	39.984	-0.076
50	Max	50.007	50.000	+0.023	49.992	50.000	+0.008	49.983	50.000	-0.001	49.966	50.000	-0.018	49.939	50.000	-0.045
	Min	49.982	49.984	-0.018	49.967	49.984	-0.033	49.958	49.984	-0.042	49.941	49.984	-0.059	49.914	49.984	-0.086
60	Max	60.009	60.000	+0.028	59.991	60.000	+0.010	59.979	60.000	-0.002	59.958	60.000	-0.023	59.924	60.000	-0.087
	Min	59.979	59.981	-0.021	59.961	59.981	-0.039	59.949	59.981	-0.051	59.928	59.981	-0.072	59.894	59.981	-0.106
80	Max	80.009	80.000	+0.028	79.991	80.000	+0.010	79.979	80.000	-0.002	79.952	80.000	-0.029	79.909	80.000	-0.072
	Min	79.979	79.981	-0.021	79.961	79.981	-0.039	79.949	79.981	-0.051	79.922	79.981	-0.078	79.879	79.981	-0.121
100	Max	100.010	100.000	+0.032	99.990	100.000	+0.012	99.976	100.000	-0.002	99.942	100.000	-0.036	99.889	100.000	-0.089
	Min	99.975	99.978	-0.025	99.955	99.978	-0.045	99.941	99.978	-0.059	99.907	99.978	-0.093	99.854	99.978	-0.146
120	Max	120.010	120.000	+0.032	119.990	120.000	+0.012	119.976	120.000	-0.002	119.934	120.000	-0.044	119.869	120.000	-0.109
	Min	119.975	119.978	-0.025	119.955	119.978	-0.045	119.941	119.978	-0.059	119.899	119.978	-0.101	119.834	119.978	-0.166
160	Max	160.012	160.000	+0.037	159.988	160.000	+0.013	159.972	160.000	-0.003	159.915	160.000	-0.060	159.825	160.000	-0.150
	Min	159.972	159.975	-0.028	159.948	159.975	-0.052	159.932	159.975	-0.068	159.875	159.975	-0.125	159.785	159.975	-0.215
200	Max	200.013	200.000	+0.042	199.986	200.000	+0.015	199.967	200.000	-0.004	199.895	200.000	-0.076	199.781	200.000	-0.190
	Min	199.967	199.971	-0.033	199.940	199.971	-0.060	199.921	199.971	-0.079	199.849	199.971	-0.151	199.735	199.971	-0.265
250	Max	250.013	250.000	+0.042	249.986	250.000	+0.015	249.967	250.000	-0.004	249.877	250.000	-0.094	249.733	250.000	-0.238
	Min	249.967	249.971	-0.033	249.940	249.971	-0.060	249.921	249.971	-0.079	249.831	249.971	-0.169	249.687	249.971	-0.313
300	Max	300.016	300.000	+0.048	299.986	300.000	+0.018	299.964	300.000	-0.004	299.850	300.000	-0.118	299.670	300.000	-0.298
	Min	299.964	299.968	-0.036	299.934	299.968	-0.066	299.912	299.968	-0.088	299.798	299.968	-0.202	299.618	299.968	-0.382
400	Max	400.017	400.000	+0.053	399.984	400.000	+0.020	399.959	400.000	-0.005	399.813	400.000	-0.151	399.586	400.000	-0.378
	Min	399.960	399.964	-0.040	399.927	399.964	-0.073	399.902	399.964	-0.098	399.756	399.964	-0.244	399.529	399.964	-0.471
500	Max	500.018	500.000	+0.058	499.983	500.000	+0.023	499.955	500.000	-0.005	499.771	500.000	-0.189	499.483	500.000	-0.477
	Min	499.955	499.960	-0.045	499.920	499.960	-0.080	499.892	499.960	-0.108	499.708	499.960	-0.292	499.420	499.960	-0.580

^a The sizes shown are first-choice basic sizes (see Table 1, page 662). Preferred fits for other sizes can be calculated from data given in ASME B4.2-1978 (R2009).

^b A plus sign indicates clearance; a minus sign indicates interference.

All dimensions are in millimeters.

Table 8a. American National Standard Running and Sliding Fits ANSI B4.1-1967 (R2009)

Nominal Size Range, Inches	Class RC 1			Class RC 2			Class RC 3			Class RC 4		
	Clearance ^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 1.2	+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 -4.4	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

Table 8b. American National Standard Running and Sliding Fits ANSI B4.1-1967 (R2009)

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

^a Pairs of values shown represent minimum and maximum amounts of clearance resulting from application of standard tolerance limits. Tolerance limits in Tables 8a and 8b 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 9a. American National Standard Clearance Locational Fits ANSI B4.1-1967 (R2009)

Nominal Size Range, Inches	Class LC 1			Class LC 2			Class LC 3			Class LC 4			Class LC 5		
	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 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

Tolerance limits given in body of Tables 9a and Tables 9b 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.

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Table 9b. American National Standard Clearance Locational Fits ANSI B4.1-1967 (R2009)

Nominal Size Range, Inches	Class LC 6			Class LC 7			Class LC 8			Class LC 9			Class LC 10			Class LC 11		
	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		Clearance ^a	Standard Tolerance Limits	
		Hole H9	Shaft f8		Hole H10	Shaft e9		Hole H10	Shaft d9		Hole H11	Shaft e10		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 -1.6	0 -1.6	1.0 2.0	+1.6 -2.0	2.5 6.6	+2.5 -4.1	-2.5 -4.1	4 12	+4 -8	-4 -8	5 17	+6 -11	-5 -11	
0.12 - 0.24	0.4 2.3	+1.2 0	-0.4 -1.1	0.8 3.8	+1.8 -2.0	0 -2.0	1.2 4.2	+1.8 -2.4	2.8 7.6	+3.0 -4.6	-2.8 -4.6	4.5 14.5	+5 -9.5	-4.5 -9.5	6 20	+7 -13	-6 -13	
0.24 - 0.40	0.5 2.8	+1.4 0	-0.5 -1.4	1.0 4.6	+2.2 -2.4	0 -2.4	1.6 5.2	+2.2 -3.0	3.0 8.7	+3.5 -5.2	-3.0 -5.2	5 17	+6 -11	-5 -11	7 25	+9 -16	-7 -16	
0.40 - 0.71	0.6 3.2	+1.6 0	-0.6 -1.6	1.2 5.6	+2.8 -2.8	0 -2.8	2.0 6.4	+2.8 -3.6	3.5 10.3	+4.0 -6.3	-3.5 -6.3	6 20	+7 -13	-6 -13	8 28	+10 -18	-8 -18	
0.71 - 1.19	0.8 4.0	+2.0 0	-0.8 -2.0	1.6 7.1	+3.5 -3.6	0 -3.6	2.5 8.0	+3.5 -4.5	4.5 13.0	+5.0 -8.0	-4.5 -8.0	7 23	+8 -15	-7 -15	10 34	+12 -22	-10 -22	
1.19 - 1.97	1.0 5.1	+2.5 0	-1.0 -2.6	2.0 8.5	+4.0 -4.5	0 -4.5	3.6 9.5	+4.0 -5.5	5.0 15.0	+6 -9.0	-5.0 -9.0	8 28	+10 -18	-8 -18	12 44	+16 -28	-12 -28	
1.97 - 3.15	1.2 6.0	+3.0 0	-1.0 -3.0	2.5 10.0	+4.5 -5.5	0 -5.5	4.0 11.5	+4.5 -7.0	6.0 17.5	+7 -10.5	-6.0 -10.5	10 34	+12 -22	-10 -22	14 50	+18 -32	-14 -32	
3.15 - 4.73	1.4 7.1	+3.5 0	-1.4 -3.6	3.0 11.5	+5.0 -6.5	0 -6.5	5.0 13.5	+5.0 -8.5	7 21	+9 -12	-7 -12	11 39	+14 -25	-11 -25	16 60	+22 -38	-16 -38	
4.73 - 7.09	1.6 8.1	+4.0 0	-1.6 -4.1	3.5 13.5	+6.0 -7.5	0 -7.5	6 16	+6 -10	8 24	+10 -14	-8 -14	12 44	+16 -28	-12 -28	18 68	+25 -43	-18 -43	
7.09 - 9.85	2.0 9.3	+4.5 0	-2.0 -4.8	4.0 15.5	+7.0 -8.5	0 -8.5	7 18.5	+7 -11.5	10 29	+12 -17	-10 -17	16 52	+18 -34	-16 -34	22 78	+28 -50	-22 -50	
9.85 - 12.41	2.2 10.2	+5.0 0	-2.2 -5.2	4.5 17.5	+8.0 -9.5	0 -9.5	7 20	+8 -12	12 32	+12 -20	-12 -20	20 60	+20 -40	-20 -40	28 88	+30 -58	-28 -58	
12.41 - 15.75	2.5 12.0	+6.0 0	-2.5 -6.0	5.0 20.0	+9.0 -11	0 -11	8 23	+9 -14	14 37	+14 -23	-14 -23	22 66	+22 -44	-22 -44	30 100	+35 -65	-30 -65	
15.75 - 19.69	2.8 12.8	+6.0 0	-2.8 -6.8	5.0 21.0	+10.0 0	0 -11	9 25	+10 -15	16 42	+16 -26	-16 -26	25 75	+25 -50	-25 -50	35 115	+40 -75	-35 -75	

^aPairs of values shown represent minimum and maximum amounts of interference resulting from application of standard tolerance limits. Limits for sizes above 19.69 inches are not covered by American-British-Canadian (ABC) agreements but are given in the ANSI Standard.