

Machining and its Importance in Engineering

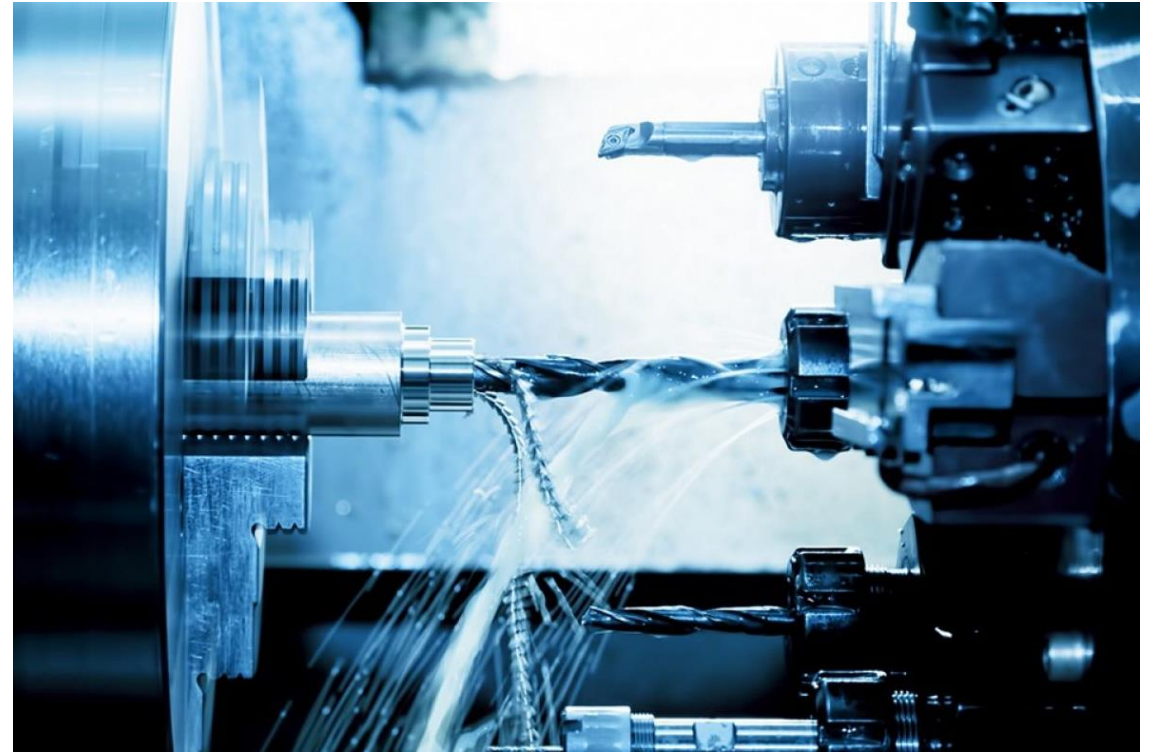


Engineering and its Importance in Machining



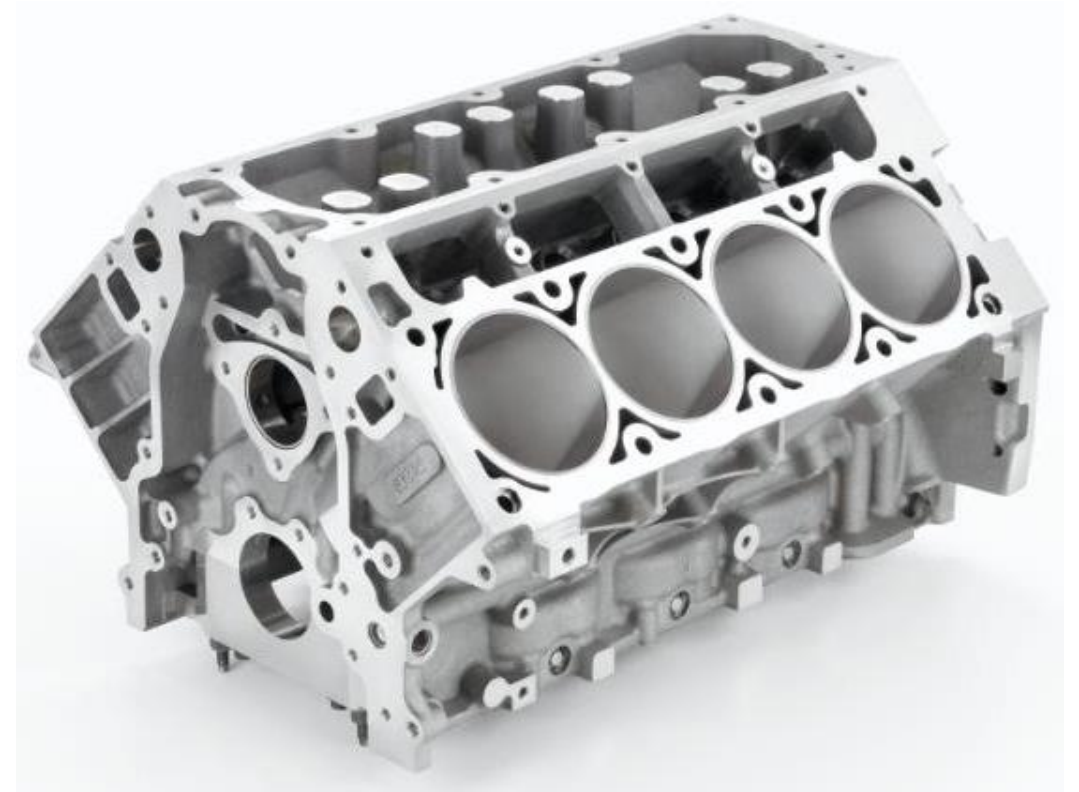
The Importance of Machining

- I'd say by now we are well aware of how machining is important.
- If we want to take our designs from the virtual to the real world, this can only be achieved through manufacturing.
- Machining is incredibly important for the manufacture of metal products, but can also be applied to plastics, woods, ceramics and composites.



The Rules of Engagement

- If we want to manufacture products, we must face reality.
- Tolerancing systems are the only way we can reconcile the perfect (nominal) dimensions in CAD/CAM and what the machine is capable of achieving.
- Let's take a closer look at one of the most important tolerancing systems in engineering.
- This is a great video that covers off all the fundamentals
 - <https://www.youtube.com/watch?v=wvVMs2BZdeU>



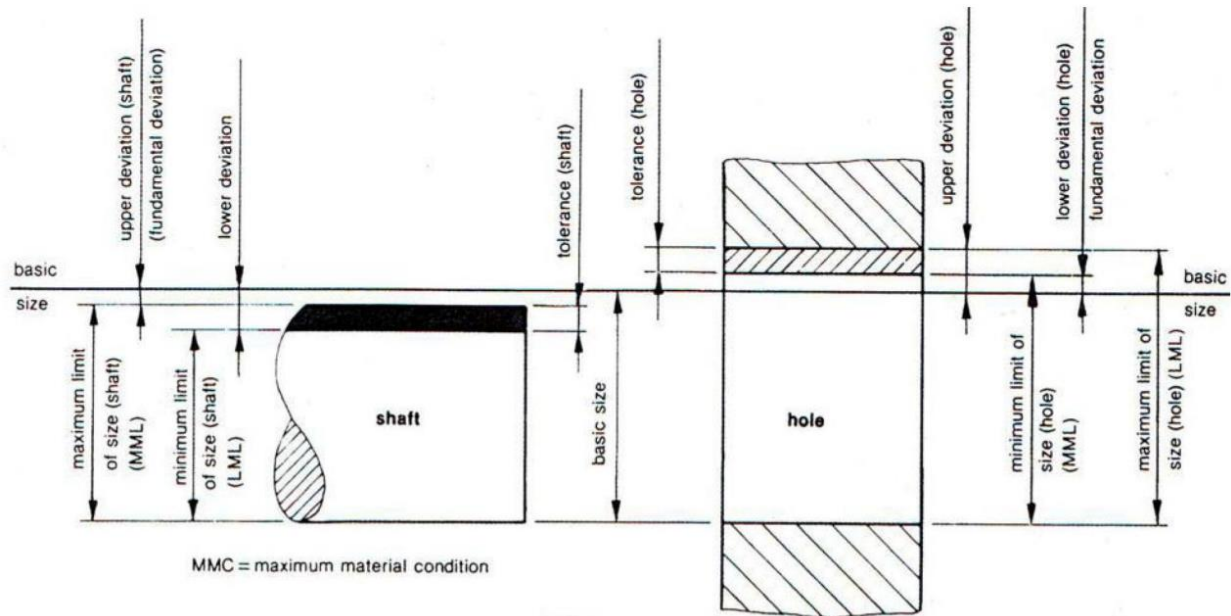
Hole-Basis and Shaft-Basis Systems

- A shaft is a component that fits into a hole.
 - Can be stationary or rotating
- A hole is a feature in a component that (often) houses or fits a shaft
 - Can also be stationary or rotating



Hole-Basis and Shaft-Basis Systems

- Any time we talk about tolerances, we need to appreciate the physical limits for the holes and shafts.
- Maximum Material Limit (MML)
 - The maximum (upper) limit for an external feature (shaft)
 - The minimum (lower) limit for an internal feature (hole)
- Least Material Limit (LML)
 - The minimum (lower) limit for an external feature (shaft)
 - The maximum (upper) limit for an internal feature (hole)

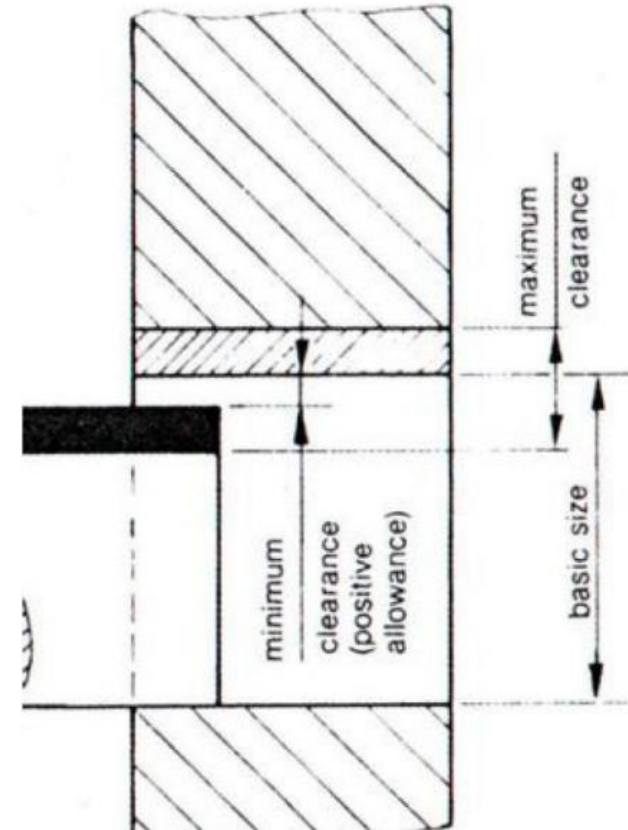


Hole-Basis and Shaft-Basis Systems

There are three main types of fits:

1. Clearance fit

- Relative motion between the shaft and the hole is always possible.
- Shaft is always smaller than the hole.
- Minimum clearance occurs at maximum shaft and minimum hole size.
- Maximum clearance occurs at minimum shaft size and maximum hole size.

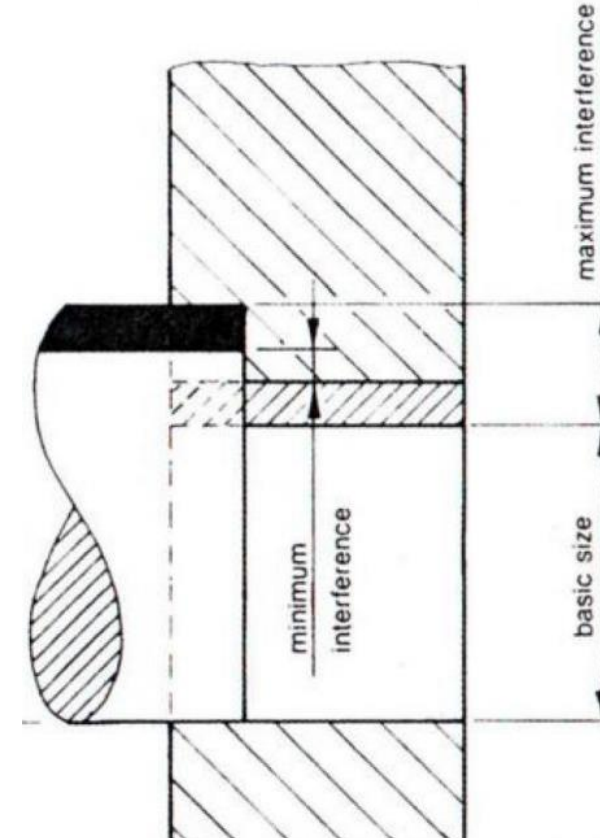


Hole-Basis and Shaft-Basis Systems

There are three main types of fits:

2. Interference fit

- Relative motion between the shaft and the hole is not possible.
- Shaft is always larger than the hole.
- Minimum interference occurs at minimum shaft and maximum hole size.
- Maximum interference occurs at maximum shaft size and minimum hole size.

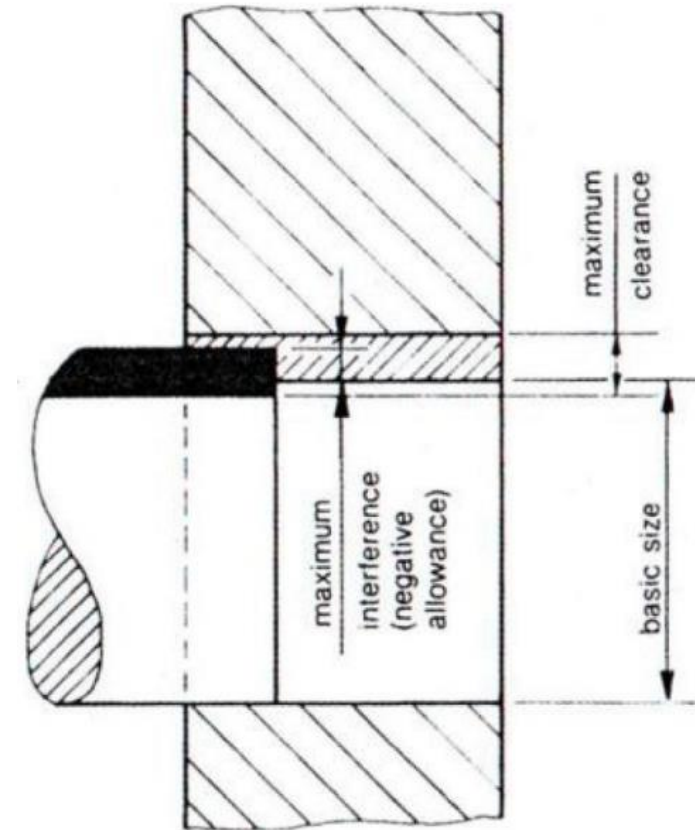


Hole-Basis and Shaft-Basis Systems

There are three main types of fits:

3. Transition fit

- Relative motion between the shaft and the hole is sometimes possible.
- The tolerance zones overlap and allows for either clearance or interference fits.
- Maximum interference occurs at maximum shaft and minimum hole size.
- Maximum clearance occurs at minimum shaft size and maximum hole size.
- Two common transition fits are light push fit and heavy push fit



Hole-Basis and Shaft-Basis Systems

- When designing systems that utilise shafts and holes, we have two options.
- Hole-basis (Tables 4.1a in Boundy)
 - Hole is treated as standard with zero fundamental deviation
 - More commonly used.
 - Easier to produce standard holes
 - Easier to turn the shaft to accommodate the hole

Hole-Basis and Shaft-Basis Systems

- When designing systems that utilise shafts and holes, we have two options.
- Shaft-basis (Tables 4.1b in Boundy)
 - Shaft is treated as standard with zero fundamental deviation
 - Is desirable in some cases when the shaft needs to have a large number of parts fitted to it.
 - » Such as?

Hole-Basis System

Clearance fit (Normal Running) H8/f7

TABLE 4.1(a) A selection of fits—hole-basis system (deviations)

CLEARANCE FITS												TRANSITION FITS		INTERFERENCE FITS	
This chart is a scale only for 25 mm basic size												= holes		= shafts	
TOLERANCE unit = 0.001mm												PRESS FIT (FERROUS)		HEAVY PRESS FIT (NON-FERROUS)	
COARSE TOLERANCE												LIGHT		HEAVY	
LOOSE												PUSH FIT			
EASY															
NORMAL RUNNING															
PRECISION RUNNING, SLIDING															
AVERAGE LOCATION															
H11/c11												H7/h6		H7/p6	
H9/d10												H7/k6		H7/n6	
H9/e9															
H8/f7															
H7/g6															
H7/h6															
H7/k6															
H7/n6															
H7/p6															
H7/s6															
OVER															
TO															
0 3												+10 0		+10 0	
3 6												+12 0		+12 0	
6 10												+15 0		+15 0	
10 18												+18 0		+18 0	
18 30												+21 0		+21 0	

Assume Basic size
31mm
diameter

Hole tolerance: +0.039 max and +0.000 min
Shaft tolerance -0.025 max and -0.050 min

30	40	+160	-120	+62	-80	+62	-50	+39	-25	+25	-9	-25	0	+25	+18	+25	-33	+25	+42	+25	+59
40	50	0	-130	0	-180	0	-112	0	-50	0	-25	0	-16	0	+2	0	+17	0	+26	0	+43
50	65	+190	-140	+74	-100	+74	-60	+46	-30	+30	-10	+30	0	+30	+21	+30	+39	+30	+51	+30	+72
65	80	0	-150	0	-220	0	-134	0	-60	0	-29	0	-19	0	+2	0	+20	0	+32	0	+78
80	100	+220	-170	+87	-120	+87	-72	+54	-36	+35	-12	+35	0	+35	+25	+35	+45	+35	+59	+35	+93
100	120	0	-180	0	-260	0	-159	0	-71	0	-34	0	-22	0	3	0	+23	0	+37	0	+101
120	140	+250	-200	+100	-145	+100	-81	+63	-43	+40	-14	+40	0	+40	+28	+40	+52	+40	+68	+40	+117
140	160	0	-210	0	-305	0	-185	0	-83	0	-39	0	-25	0	+3	0	+27	0	+43	0	+125
160	180	+280	-230	+115	-170	+115	-100	+72	-50	+46	-15	+46	0	+46	+33	+46	+60	+46	+79	+46	+151
180	200	0	-240	0	-355	0	-215	0	-96	0	-44	0	-29	0	+4	0	+31	0	+50	0	+159
200	225	+290	-240	+130	-190	+130	-110	+81	-58	+52	-17	+52	0	+52	+36	+52	+66	+52	+88	+52	+172
225	250	0	-260	0	-400	0	-240	0	-108	0	-49	0	-32	0	+4	0	+34	0	+56	0	+202
250	280	+320	-300	+140	-210	+140	-125	+89	-62	+57	-18	+57	0	+57	+40	+57	+73	+57	+98	+57	+226
280	315	0	-330	0	-440	0	-265	0	-119	0	-54	0	-36	0	+4	0	+37	0	+62	0	+244
315	355	+360	-360	+155	-230	+155	-135	+97	-68	+63	-20	+63	0	+63	+45	+63	+80	+63	+108	+63	+272
355	400	0	-400	0	-500	0	-300	0	-141	0	-60	0	-40	0	+5	0	+48	0	+76	0	+300
400	450	+400	-440	+165	-250	+165	-150	+107	-78	+70	-22	+70	0	+70	+50	+70	+90	+70	+120	+70	+322

Shaft-Basis System Example

Clearance fit (Normal Running) F8/h7

TABLE 4.1(b) A selection of fits—shaft-housing system (deviations)

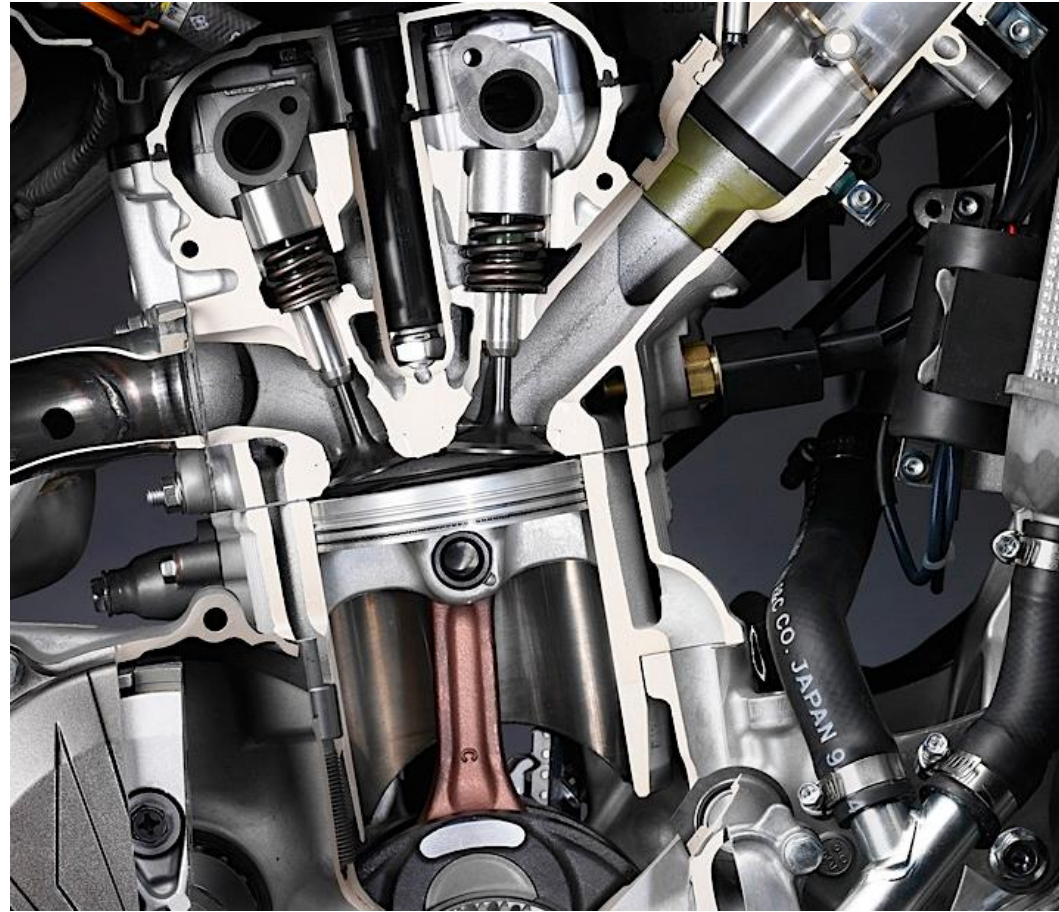
CLEARANCE FITS										TRANSITION FITS				INTERFERENCE FITS							
TOLERANCE use 0.001mm										LIGHT		HEAVY		PRESS FIT (FERROUS)		HEAVY PRESS FIT (NON-FERROUS)					
		COARSE TOLERANCE		LOOSE		EASY		NORMAL RUNNING		PRECISION RUNNING, SLIDING		AVERAGE LOCATION									
				RUNNING FIT																	
												PUSH FIT									
BASIC SIZES (mm)		C11/h11		D10/h9		E9/h9		F8/h7		G7/h6		H7/h6		K7/h6		N7/h6		P7/h6		S7/h6	
OVER	TO																				
0	3	+120 +60	0 -60	+20 +20	-25 -25	+39 +14	-25 -25	+20 +6	0 -10	+12 +2	0 -6	+10 0	0 -6	0 -10	0 -6	-4 -14	0 -6	-6 -16	0 -6	-14 -24	0 -24
3	6	+145 +70	-75 -30	+78 +30	0 -30	+50 -30	0 -30	+28 +10	0 -12	+16 +4	0 -8	+12 0	0 -8	+3 -9	0 -8	-4 -16	0 -8	-8 -20	0 -8	-15 -27	0 -27
6	10	+170 +80	-90 -30	+98 +40	0 -36	+61 +25	0 -36	+35 +13	0 -15	+20 +5	0 -9	+15 0	0 -9	+5 -10	0 -9	-4 -14	9 -9	-24 -9	0 -9	-17 -32	0 -32
10	18	+205 +95	-110 -40	+120 +50	0 -43	+75 +32	0 -43	+43 +16	0 -18	+24 +6	0 -11	+18 0	0 -11	+6 -12	0 -11	-5 -23	0 -11	-11 -21	0 -11	-21 -39	0 -39
18	30	+240 +110	-130 -50	+149 +65	0 -52	+92 +40	0 -52	+53 +20	0 -21	+28 +7	0 -13	+21 0	0 -13	+6 -15	0 -13	-7 -28	0 -13	-14 -35	0 -13	-27 -48	0 -48

Assume Basic size
31mm
diameter

Hole tolerance: +0.064 max and +0.025 min
Shaft tolerance: -0.000 max and -0.025 min

30	40	+280 +120	0 -160	+180	0	+112	0	+64	0	+34	0	+25	0	+7	0	-8	0	-17	0	-34	-1
40	50	+290 +130	0 -160	+80	-62	+50	-62	+25	-25	+9	-16	0	-16	-18	-16	-33	-16	-42	-16	-59	-1
50	65	+330 +140	0 -190	+220	0	+134	0	+76	0	+40	0	+30	0	+9	0	-9	0	-21	0	-42	-72
65	80	+340 +150	0 -190	+100	-74	+60	-74	+30	-30	+10	-19	0	-19	-21	-19	-39	-19	-51	-19	-48	-1
80	100	+390 +170	0 -220	+260	0	+159	0	+90	0	+47	0	+35	0	+10	0	-10	0	-24	0	-58	-93
100	120	+400 +180	0 -220	+120	-87	+72	-87	+36	-35	+12	-22	0	-22	-25	-22	-45	-22	-59	-22	-66	-101
120	140	+450 +200	0 -250	+305	0	+185	0	+106	0	+54	0	+40	0	+12	0	-12	0	-28	0	-77	-117
140	160	+460 +210	0 -250	+145	-100	+85	-100	+43	-40	+14	-25	0	-25	-28	-25	-52	-25	-68	-25	-85	-125
160	180	+480 +230	0 -250																	-93	-133
180	200	+530 +240	0 -290	+355	0	+215	0	+122	0	+61	0	+46	0	+13	0	-14	0	-33	0	-105	-151
200	225	+550 +260	0 -290	+170	-115	+100	-115	+50	-46	+15	-29	0	-29	-33	-29	-60	-29	-79	-29	-113	-159
225	250	+570 +280	0 -290																	-123	-169
250	280	+620 +300	0 -320	+400	0	+240	0	+137	0	+62	0	+52	0	+16	0	-14	0	-36	0	-138	-190
280	315	+650 +330	0 -320	+190	-130	+110	-130	+56	-52	+17	-32	0	-32	-36	-32	-66	-32	-88	-32	-150	-202
315	355	+720 +360	0 -360	+440	0	+265	0	+151	0	+75	0	+57	0	+17	0	-16	0	-41	0	-169	-226
355	400	+760 +400	0 -360	+210	-140	+125	-140	+62	-57	+18	-36	0	-36	-40	-36	-73	-36	-98	-36	-187	-244
400	450	+840 +440	0 -400	+480	0	+290	0	+165	0	+83	0	+63	0	+18	0	-17	0	-48	0	-209	-272

What fit and system is best here?



What fit and system is best here?



What fit and system is best here?

