USEFUL TOLERANCES (mm)

Tolerance		Nominal Diameter (mm) from 1 to 3	over 3 to 6	over 6 to 10	over 10 to 18	over 18 to 30	over 30 to 50	over 50 to 80	over 80 to 120
SHAFTS	e^8	-.014 -.028	-.020 -.038	-.025 -.047	-.032 -.059	-.040 -.073	-.050 -.089	-.060 -.106	-.072 -.126
	e^9	-.014 -.039	-.020 -.050	-.025 -.061	-.032 -.075	-.040 -.092	-.050 -.112	-.060 -.134	-.072 -.159
	f^6	-.006 -.012	-.010 -.018	-.013 -.022	-.016 -.027	-.020 -.033	-.025 -.041	-.030 -.049	-.036 -.058
	f^7	-.006 -.016	-.010 -.022	-.013 -.028	-.016 -.034	-.020 -.041	-.025 -.050	-.030 -.060	-.036 -.071
	g^6	-.002 -.008	-.004 -.012	-.005 -.014	-.006 -.017	-.007 -.020	-.009 -.025	-.010 -.129	-.012 -.134
	h^6	.000 -.006	.000 -.008	.000 -.009	.000 -.011	.000 -.013	.000 -.016	.000 -.019	.000 -.022
	h^7	.000 -.010	.000 -.012	.000 -.015	.000 -.018	.000 -.021	.000 -.025	.000 -.030	.000 -.035
	h^8	.000 -.014	.000 -.018	.000 -.022	.000 -.027	.000 -.033	.000 -.039	.000 -.046	.000 -.054
	h^9	.000 -.025	.000 -.030	.000 -.036	.000 -.043	.000 -.052	.000 -.062	.000 -.074	.000 -.087
	h^{11}	.000 -.060	.000 -.075	.000 -.090	.000 -.110	.000 -.130	.000 -.160	.000 -.190	.000 -.220
	h^{12}	.000 -.100	.000 -.120	.000 -.150	.000 -.180	.000 -.210	.000 -.250	.000 -.300	.000 -.350
	k^6	+.006 .000	+.009 +.001	+.010 +.001	+.012 +.001	+.015 +.002	+.018 +.002	+.021 +.002	+.025 +.003
	n^6	+.010 +.004	+.016 +.008	+.019 +.010	+.023 +.012	+.028 +.015	+.033 +.017	+.039 +.020	+.045 +.023
	p^6	+.012 +.006	+.020 +.012	+.024 +.015	+.029 +.018	+.035 +.022	+.042 +.026	+.051 +.032	+.059 +.037
HOLES	F^8	+.020 +.006	+.028 +.010	+.035 +.013	+.043 +.016	+.053 +.020	+.064 +.025	+.076 +.030	+.090 +.036
	G^7	+.012 +.002	+.016 +.004	+.020 +.005	+.024 +.006	+.028 +.007	+.034 +.009	+.040 +.010	+.047 +.012
	H^7	+.010 .000	+.012 .000	+.015 .000	+.018 .000	+.021 .000	+.025 .000	+.030 .000	+.035 .000
	H^8	+.014 .000	+.018 .000	+.022 .000	+.027 .000	+.033 .000	+.039 .000	+.046 .000	+.054 .000
	H^9	+.025 .000	+.030 .000	+.036 .000	+.043 .000	+.052 .000	+.062 .000	+.074 .000	+.087 .000
	H^{12}	+.100 .000	+.120 .000	+.150 .000	+.180 .000	+.210 .000	+.250 .000	+.300 .000	+.350 .000

PREFERRED FITS

The following chart covers a simple selection of Fits for Shafts and Holes which will meet the needs of a large proportion of the requirements for normal engineering products.

Shaft Basis	Hole Basis	Description / Application
		CLEARANCE FITS
C11 / h11	H11 / c11	**LOOSE RUNNING FIT** - Wic̶e commercial tolerances, used where accuracy is not essential.
D9 / h9	H9 / e9	**FREE RUNNING FIT** - High running speeds, large temperature variations, heavy pressures and where accuracy is not essential.
F8 / h7	H8 / f7	**CLOSE RUNNING FIT** - Accurate location at moderate speeds on accurate machines.
G7 / h6	H7 / g6	**SLIDING FIT** - Accurate location where components are intended to move and turn freely but not run freely.
H7 / h6	H7 / h6	**LOCATIONAL CLEARANCE FIT** - Snug fit for locating stationary components which need to be freely assembled and disassembled.
		TRANSITION FITS
K7 / h6	H7 / k6	**LOCATIONAL TRANSITION FIT** (Tap Fit) - Accurate location where assembly requires gentle persuasion.
N7 / h6	H7 / n6	**LOCATIONAL TRANSITION FIT** - More accurate location where assembly permits greater interference.
		INTERFERENCE FITS
P7 / h6	H7 / p6	**LOCATIONAL INTERFERENCE** - Prime accuracy of location where assembly requires alignment and rigidity.
S7 / h6	H7 / s6	**MEDIUM DRIVE FIT** (Press Fit) - For assembly of steel parts and shrink fits on light sections.
U7 / h6	H7 / u6	**FORCE FIT** (Press Fit) - For assembly of components where high pressures and stresses are permitted.

Note: See pages 56 and 57 for tolerances.

FITS FOR SHAFTS & HOLES

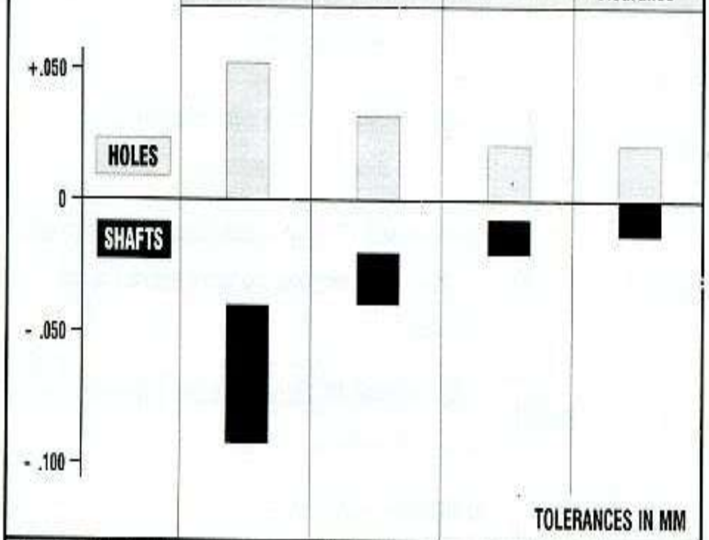
The following table covers a simple selection of Fits - (Hole Basis) which will meet the needs of a large proportion of the requirements for normal engineering products.

To scale for diameter range 18 mm to 30 mm

Type of Fit

CLEARANCE

Free Running	Close Running	Sliding	Locational Clearance



Nominal Size (mm) above	Nominal Size (mm) upto & incl.	H^9	e^9	H^8	f^7	H^7	g^6	H^7	h^6
0	3	+.025 .000	-.014 -.039	+.014 .000	-.060 -.016	+.010 .000	-.020 -.080	+.010 .000	-.060 -.000
3	6	+.030 .000	-.020 -.050	+.018 .000	-.010 -.022	+.012 .000	-.040 -.012	+.012 .000	-.080 .000
6	10	+.036 .000	-.025 -.061	+.022 .000	-.013 -.028	+.015 .000	-.050 -.014	+.015 .000	-.090 .000
10	18	+.043 .000	-.032 -.075	+.027 .000	-.016 -.034	+.018 .000	-.060 -.017	+.018 .000	-.011 .000
18	30	+.052 .000	-.040 -.092	+.033 .000	-.020 -.041	+.021 .000	-.070 -.020	+.021 .000	-.013 .000
30	50	+.062 .000	-.050 -.112	+.039 .000	-.025 -.050	+.025 .000	-.090 -.025	+.025 .000	-.016 .000
50	80	+.074 .000	-.060 -.134	+.046 .000	-.030 -.060	+.030 .000	-.010 -.029	+.030 .000	-.019 .000
80	120	+.087 .000	-.072 -.159	+.054 .000	-.036 -.071	+.035 .000	-.012 -.034	+.035 .000	-.022 .000
120	180	+.100 .000	-.084 -.185	+.063 .000	-.043 -.083	+.040 .000	-.014 -.039	+.040 .000	-.025 .000
180	250	+.115 .000	-.100 -.215	+.072 .000	-.050 -.096	+.046 .000	-.015 -.044	+.046 .000	-.029 .000
250	315	+.130 .000	-.110 -.240	+.081 .000	-.056 -.108	+.052 .000	-.017 -.049	+.052 .000	-.032 .000
315	400	+.140 .000	-.125 -.265	+.089 .000	-.062 -.119	+.057 .000	-.018 -.054	+.057 .000	-.036 .000
400	500	+.155 .000	-.135 -.290	+.097 .000	-.068 -.131	+.063 .000	-.020 -.060	+.063 .000	-.040 .000

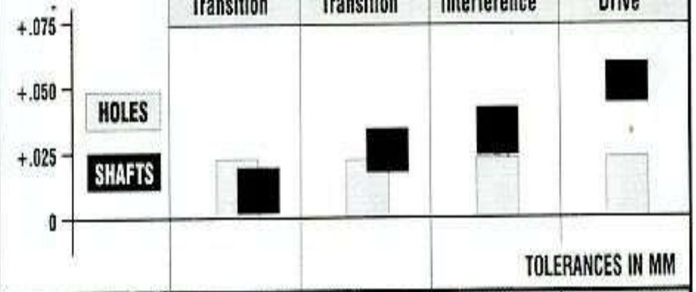
FITS FOR SHAFTS & HOLES

The following table covers a simple selection of Fits - (Hole Basis) which will meet the needs of a large proportion of the requirements for normal engineering products.

To scale for diameter range 30 mm to 50 mm

Type of Fit

TRANSITION		INTERFERENCE	
Locational Transition	Locational Transition	Locational Interference	Medium Drive



Nominal Size (mm) above	Nominal Size (mm) upto & incl.	H^7	k^6	H^7	n^6	H^7	p^6	H^7	s^6
0	3	+.010 .000	+.006 .000	+.010 .000	+.010 +.004	+.010 .000	+.012 +.006	+.010 .000	+.020 +.014
3	6	+.012 .000	+.009 +.001	+.012 .000	+.016 +.008	+.012 .000	+.020 +.012	+.012 .000	+.027 +.019
6	10	+.015 .000	+.010 +.001	+.015 .000	+.019 +.010	+.015 .000	+.024 +.015	+.015 .000	+.032 +.023
10	18	+.018 .000	+.012 +.001	+.018 .000	+.023 +.012	+.018 .000	+.029 +.018	+.018 .000	+.039 +.028
18	30	+.021 .000	+.015 +.002	+.021 .000	+.028 +.015	+.021 .000	+.035 +.022	+.021 .000	+.048 +.035
30	50	+.025 .000	+.018 +.002	+.025 .000	+.033 +.017	+.025 .000	+.042 +.026	+.025 .000	+.059 +.043
50	65	+.030 .000	+.021 +.002	+.030 .000	+.039 +.020	+.030 .000	+.051 +.032	+.030 .000	+.072 +.053
65	80							+.030 .000	+.078 +.059
80	100	+.035 .000	+.025 +.003	+.035 .000	+.045 +.023	+.035 .000	+.059 +.037	+.035 .000	+.093 +.071
100	120							+.035 .000	+.101 +.079
120	140							+.040 .000	+.117 +.092
140	160	+.040 .000	+.028 +.003	+.040 .000	+.052 +.027	+.040 .000	+.068 +.043	+.040 .000	+.125 +.100
160	180							+.040 .000	+.133 +.108
180	200							+.046 .000	+.151 +.122
200	225	+.046 .000	+.033 +.004	+.046 .000	+.060 +.031	+.046 .000	+.079 +.050	+.046 .000	+.159 +.130
225	250							+.046 .000	+.169 +.140
250	280	+.052 .000	+.036 +.004	+.052 .000	+.066 +.034	+.052 .000	+.088 +.056	+.052 .000	+.190 +.158
280	315							+.052 .000	+.202 +.170
315	355	+.057 .000	+.040 +.004	+.057 .000	+.073 +.037	+.057 .000	+.098 +.062	+.057 .000	+.226 +.190
355	400							+.057 .000	+.244 +.208
400	450	+.063 .000	+.045 +.005	+.063 .000	+.080 +.040	+.063 .000	+.108 +.068	+.063 .000	+.272 +.232
450	500							+.063 .000	+.292 +.252

4

Limits—Fits and tolerances

When component parts are to be assembled, one of the first things that becomes apparent is that diverse degrees of slackness or tightness are necessary between mating parts to ensure that the assembled article is satisfactory. This degree of slackness is usually referred to as the fit of the parts. Each part in the assembly is made within certain limits of size, which is referred to as the tolerance.

Types of fit

Clearance Fits

Where it is necessary to have movement between parts, the hole will need to be larger than the male component to provide a suitable clearance between them. Such fits are called clearance fits (Fig. 1). The types of clearance fit, with their identifying symbols, are listed on page 40.

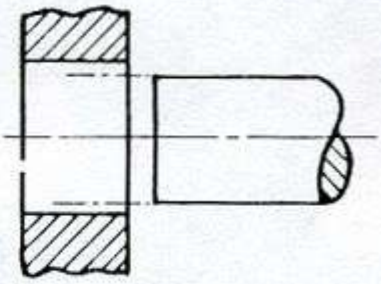


Figure 1 Clearance fit

Interference Fits

When parts are required to fit tightly together, such as when a bush is required to fit into a hole in a boss, it is necessary for the outside of the bush to be slightly larger than the hole. When the bush is pressed in, the force between the components tends to expand the boss and contract the bush. If the difference in size, which is called the allowance for the fit, is suitable, the expansion of the boss and the contraction of the bush will be slight, while the elasticity of the material will maintain the fit. However, if the allowance is too great one or both of the parts may fracture or the smooth finish of the matin surface may be torn.

This type of fit, in which the female component is smalle than the male component, is known as an interferenc fit (Fig. 2). There are several kinds of interference fit a described below.

Light press fit   The allowance is only small and the part can be assembled with relatively light force.

Press fit   The allowance is greater.

Heavy press fit   The allowance is bigger and more forc is required to assemble the parts; the grip between th components is greater and larger forces can be exerte on the parts without separating them.

Shrink fit   This is used when the greatest possible gri must be obtained, and the allowance is too great to pe mit the forcing together of the components witho damage.

Under these circumstances it is necessary to expand tl external component by heat or contract the internal cor ponent by cooling in order to assemble them.

Transition Fits

Between the two major classifications of interference ai clearance fits there is an intermediate type, usually call a transition fit (Fig. 3). This occurs when the parts a almost the same size. Very small differences in size c be obtained between parts that have finely finished ai accurate surfaces.

If the surfaces are finely finished with a slight degr of taper, mating components with a very small interf ence can be assembled with the amount of force usual regarded as a push fit. However, in most cases, a pu fit occurs when components have insufficient clearan to permit them to slide or rotate freely. Very sm changes in tolerance produce considerable differences the nature of the fit.

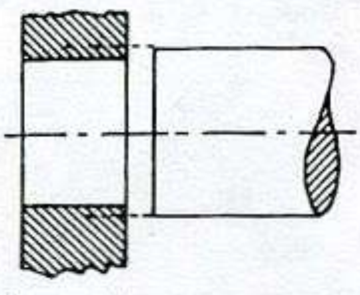


Figure 2 Interference fit

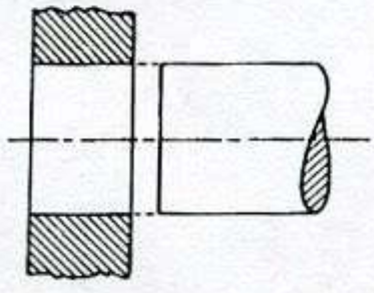


Figure 3 Transition fit

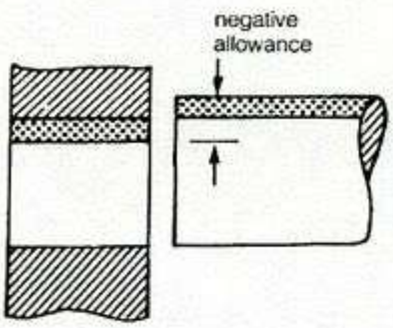


Figure 6 Negative allowance

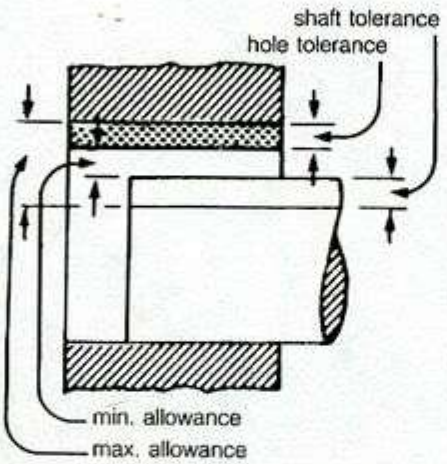


Figure 7 Disposition of tolerance and allowance

Clearance Fit

This is a fit between mating parts having limits of size that always result in a positive allowance (clearance between mating parts) (see Fig. 8).

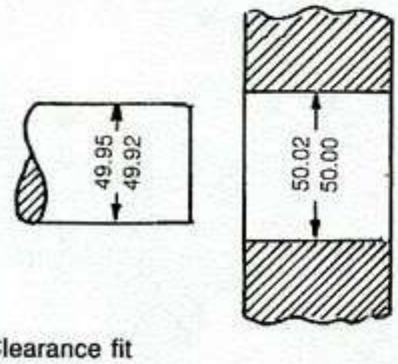


Figure 8 Clearance fit

Example: Basic size of shaft and hole is 50 mm.

Hole size:

Minimum diameter = 50.00 mm
Maximum diameter = basic size plus tolerance (say 0.02) = 50.02 mm

Shaft size:

Maximum diameter = minimum hole size minus allowance (say 0.05)
= 50.00 − 0.05 = 49.95 mm
Minimum diameter = maximum diameter minus tolerance (say 0.03)
= 45.95 − 0.03 = 49.92 mm

Extreme conditions:

Tightest fit = min. hole − max. shaft
= 50.00 − 49.95
= 0.05 mm clearance
Slackest fit = max. hole − min. shaft
= 50.02 − 49.92
= 0.10 mm clearance

Transition Fit

A transition fit is a fit between mating parts having limits of size that may result in small degrees of clearance or interference (Fig. 9).

Example: Basic size of shaft and hole is 50 mm

Hole size:

Minimum diameter = 50 mm = basic size
Tolerance on hole = + 0.02 mm
Maximum diameter = 50.02 mm

Assume allowance (occurs with tightest fit) = 0.02 mm interference

Shaft size:

Maximum diameter = minimum hole + allowance
Maximum diameter = 50 + 0.02 mm
= 50.02 mm
Tolerance on shaft = − 0.02 mm
Minimum diameter = 50.00 mm

Extreme conditions:

Tightest fit = max. shaft − min. hole
= 50.02 − 50 mm
= 0.02 mm interference
Slackest fit = max. hole − min. shaft
= 50.02 − 50 mm
= 0.02 mm interference

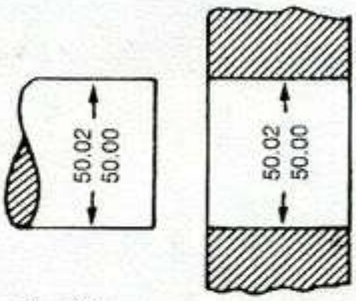


Figure 9 Transition fit

Interference Fit

An interference fit is a fit between mating parts having limits of size that always result in a negative allowance (interference between assembled parts (Fig. 10).

Example: Basic size of shaft and hole = 50 mm

Hole size:

Minimum diameter = 50 mm = basic size
Tolerance on hole = 50.00 + 0.02 mm
Maximum diameter = 50.02 mm

Assume allowance = 0.08 mm interference

Shaft size:

Maximum diameter = minimum hole + allowance
Maximum diameter = 50 + 0.08 mm
= 50.08 mm
Tolerance on shaft = 50.08 − 0.02 mm
Minimum diameter = 50.06 mm

Extreme conditions:

Tightest fit = max. shaft − min. hole
= 50.08 − 50 mm
= 0.08 mm interference

Slackest fit = min. shaft − max. hole
= 50.06 − 50.02 mm
= 0.04 mm interference

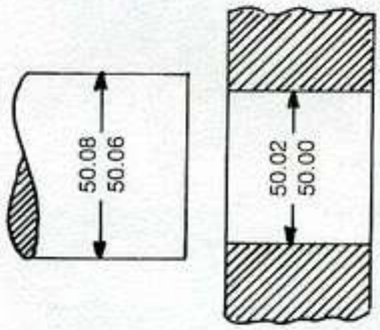


Figure 10 Interference fit

Note: It can be seen from these examples that the use of tolerances on the size of mating components introduce a variation in the possible fits obtained that is equal in all cases to the sum of the tolerances of the two parts.

Basic Hole System

The basic hole system of fits is a system in which the minimum limit of each hole size is basic. The fit desired is obtained by varying the allowance of the shaft and the tolerances of the mating parts. The hole is usually the simpler part to produce, being machined by drilling, reaming, boring, etc. The minimum size is measured and the limits of size for the shaft are arranged to suit the type of fit.

Basic Shaft System

The basic shaft system of fits is a system in which the maximum limit of each shaft size is the basic size. The fit desired is obtained by varying the allowance of the hole and the tolerances of the mating parts. The system uses standard shafting or similar easy-to-obtain standard sizes. The maximum size is measured and the limits of size for the hole arranged to suit the type of fit.

Standard system of limits and fits

This system provides the basis for determining the selection of tolerances to be shown on working drawings in order to obtain the desired fit.

Tolerances

The system (Australian Standard 1654) provides for 18 grades of tolerance for each size range, designated grade 01 to 16. Seven of these, 6 to 12, will cover a simple selection of tolerances for general engineering purposes.

The tolerance grade indicates the tolerance permitted for a dimension; for example, grade H8 for a hole of size between 18 and 30 mm is 0.033 mm. This means that a hole with basic size of 25 mm with this tolerance grade would have limits of 25.00 and 25.03 mm.

The tolerance for a particular grade varies for different sizes; for example, H8 for a size between 30 and 50 mm is 0.039 mm. It can be seen that for the increase

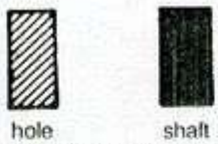


Figure 11 Symbols indicating tolerance zones

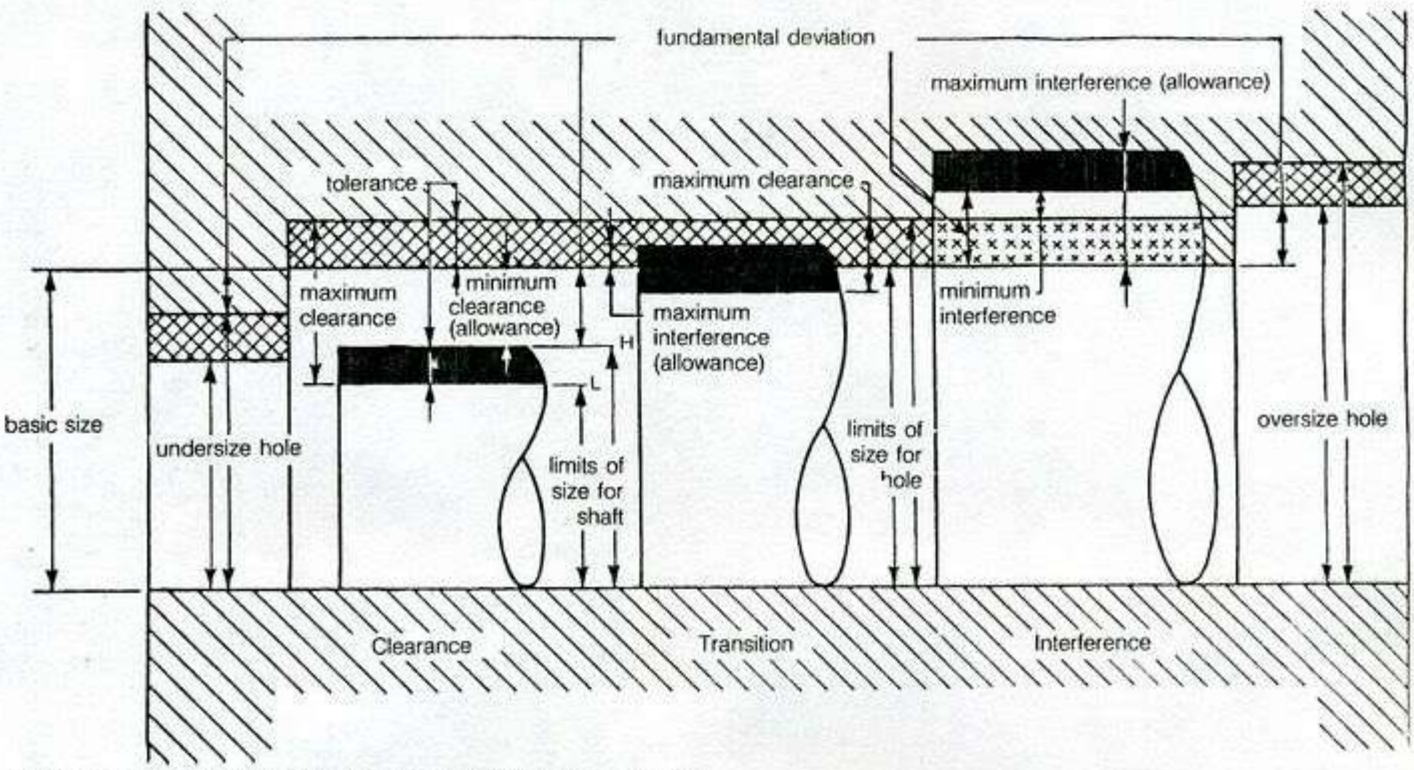


Figure 12 Disposition of limits and tolerances (basic hole)