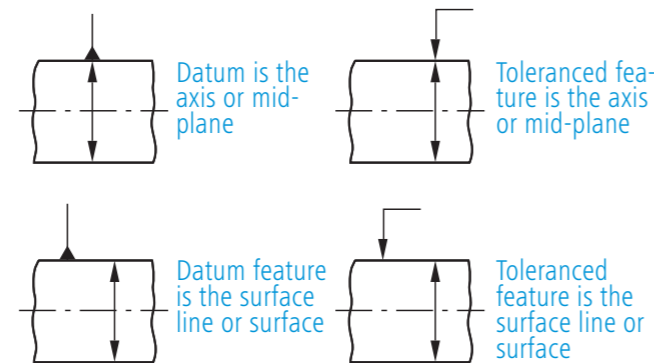
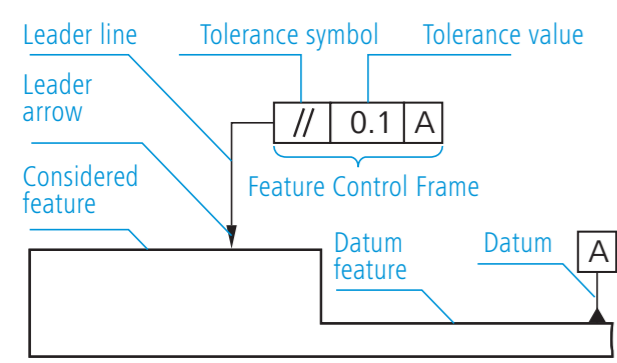


Form and location tolerances according to ASME Y14.5

Form tolerances limit the deviations of an individual feature from its geometrically ideal form. Orientation, location and runout tolerances limit the errors of the mutual location of two or more features. One or more features can be specified as datum features.



	Circularity (form tolerance): the tolerance zone is limited in the measuring plane perpendicular to the measuring axis by two concentric circles a distance t apart.		
	Straightness (form tolerance): the tolerance zone is limited by - a cylinder of diameter t (□ of a derived median line) - two parallel planes a distance t apart (□ of an edge) - two parallel lines a distance t apart (□ of a surface line).		
	Cylindricity (form tolerance): the tolerance zone is limited by two coaxial cylinders a distance t apart. <input checked="" type="checkbox"/> limits implicitly: <input checked="" type="checkbox"/> and <input checked="" type="checkbox"/> _axis and <input checked="" type="checkbox"/> _surface and <input checked="" type="checkbox"/> _surface		
	Flatness (form tolerance): the tolerance zone is limited by two parallel planes a distance t apart. <input checked="" type="checkbox"/> limits implicitly: <input checked="" type="checkbox"/> _surface OR <input checked="" type="checkbox"/> _derived median line		

Unlike form tolerances, location tolerances almost always require one or multiple datums:

	Parallelism (orientation tolerance): the tolerance zone is limited by two parallel lines or planes a distance t apart, which are parallel to the datum. <input checked="" type="checkbox"/> limits implicitly: <input checked="" type="checkbox"/> _surface OR <input checked="" type="checkbox"/> _derived median line/axis		
	Perpendicularity (orientation tolerance): the tolerance zone is limited by two parallel planes a distance t apart (or a cylinder with Ø t) which are perpendicular to the datum. <input checked="" type="checkbox"/> limits implicitly: <input checked="" type="checkbox"/> _surface OR <input checked="" type="checkbox"/> _derived median line/axis		
	Angularity (orientation tolerance): the tolerance zone is limited by two parallel planes a distance t apart (or a cylinder with Ø t) which are at the defined angle to the primary datum. <input checked="" type="checkbox"/> limits implicitly: <input checked="" type="checkbox"/> _surface OR <input checked="" type="checkbox"/> _derived median line/axis		
	Position (location tolerance): the tolerance zone is limited by a cylinder of diameter t coaxial to the datum (position with Ø sign). <input checked="" type="checkbox"/> limits implicitly: <input checked="" type="checkbox"/> _Z, if applicable also <input checked="" type="checkbox"/> _X and <input checked="" type="checkbox"/> _plane		
	Symmetry (location tolerance): the tolerance zone is limited by two planes symmetrical to the datum axis or datum plane at a distance t apart. (Obsolete, not used any more.) <input checked="" type="checkbox"/> limits implicitly: <input checked="" type="checkbox"/> _center plane <input checked="" type="checkbox"/> _center plane if applicable <input checked="" type="checkbox"/> _center plane		
	Concentricity (location tolerances): the tolerance zone is limited by a cylinder or circle of diameter t which is coaxial or concentric to the datum. (Obsolete, not used any more.) <input checked="" type="checkbox"/> Coaxiality limits implicitly: <input checked="" type="checkbox"/> _axis <input checked="" type="checkbox"/> _axis <input checked="" type="checkbox"/> _concentricity		
	Line profile (profile tolerance with and without datum): the tolerance zone is limited by two curves which envelop circles of diameter t whose mid-points are on a curve of geometrically ideal form. If applicable: a datum limits the position		
	Profile of a surface (profile tolerance with and without datum): the tolerance zone is limited by two surfaces which envelop spheres of diameter t whose mid-points are on a curve of geometrically ideal form. If applicable: a datum limits the location.		
	Circular radial or axial run-out (run-out tolerances): the tolerance zone is limited by two concentric circles or parallel planes a distance t apart, which are located by datum A-B. <input checked="" type="checkbox"/> Circular radial run-out limits: <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Circular axial run-out limits: <input checked="" type="checkbox"/>		
	Total radial or axial run-out (run-out tolerances): the tolerance zone is limited by two concentric cylinders or parallel planes a distance t apart, which are located by datum A-B. <input checked="" type="checkbox"/> Total radial runout limits: <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> Total axial run-out limits: <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>		

Additional drawing entries according to ASME Y14.5

In many cases, circled characters can be entered in the feature control frame next to the tolerance (and/or sometimes also next to a datum).

	Maximum material requirement: M permits the addition of unused dimension tolerance portions to the toleranced form or location error. Example (simple case): cylinder diameter 6 mm and the axis straightness tolerance $t = 0.5$ mm (see image to the right). If the actual diameter is 5.0 mm, the straightness of the axis can deviate up to 1.5 mm.	
	Least material requirement: L enables the addition of unused dimension tolerance portions (away from the material side) to the toleranced form or location error. Example (simple case): cylinder diameter 6 mm and axis straightness tolerance $t = 0.5$ mm (see image to the right). If the actual diameter is 6.0 mm, the straightness of the axis can deviate up to 1.5 mm.	
	Independency requirement: this symbol invokes the „Principle of Independency“ instead of ASME Rule #1. This principle sets no limits to the number of errors of form possessed by individual features of a workpiece. International designer, except the USA, use this principle as default (ISO GPS standardization).	
	Tangent plane: the toleranced and measured feature must be evaluated as an external tangential feature (as per the Chebyshev minimum method) (OTPL).	
	Free state: the inspection of the (elastic or plastic, non-rigid) workpiece must be performed in the unfixed state (only formed by gravity).	
	Unequally disposed profile tolerances: the tolerance zone of value t is shifted to outside the material. The value after U indicates the amount of tolerance in +material direction. In the example to the right, the zone is entirely outside of the material.	
	Projected tolerance zone: this symbol tolerance zone has been moved by t entirely outside of the workpiece in order to inspect the locations relevant for later assembly.	
	Continuous Feature: this symbol is used to identify a group of two or more features where there is a requirement that they be treated geometrically as a single feature. Rule #1 applies here.	
	Statistical Tolerance: Features controlled by a statistical tolerance shall be produced with statistical process controls (SPC).	

Tolerance zones and datum features can also be limited in their configuration and direction of action:

Ø	Diameter: this symbol defines a circular tolerance zone of diameter t or indicates a circular feature when used on the field of a drawing.	
SØ	Spherical Diameter: this symbol defines a spherical tolerance zone of diameter t.	
R	Radius: symbol R creates a tolerance zone defined by two arcs (minimum and maximum radii) that are tangent to the adjacent surfaces.	
SR	Spherical Radius: SR creates a tolerance zone defined by two sphere segments (minimum and maximum radii) tangent to adjacent surfaces.	
CR	Controlled Radius: symbol CR creates a tolerance zone defined by two arcs (minimum and maximum radii) that are tangent to the adjacent surfaces and the part contour has to be a fair curve without reversals.	
▷	Datum Translation: datum feature only acts as an orientation feature. The position coordinates are not considered.	
A↔B	Between (tolerance zone limitation): the tolerance must be inspected only in the area between A and B.	
t/...	Tolerance zone limitation: the tolerance of 0.5 cannot be exceeded in any section of the length 100 (in the example to the right).	
⦿	All Around: the tolerance applies to all line and surface features surrounding the entire workpiece in the viewing plane.	
⦿	All Over: the tolerance applies to all surfaces surrounding the entire workpiece.	
△	Dynamic Profile: the profile zone only controls form of the feature, not size. It can be used for profiles with and without datum.	
⦿	Dimension origin: this symbol is indicating that a toleranced dimension between two features originates from the one marked with the dimension origin symbol and not the other.	

GD&T – Geometric Dimensioning & Tolerancing

