Rule #1

Limits of Size Prescribe Variations of Form

Rule #1 states that for an individual regular feature of size, where only a tolerance of size is specified, the limits of size prescribe the extent to which variations in its geometric form, as well as its size, are allowed. No element of a feature of size shall extend beyond the maximum material condition boundary (envelope) of perfect form. The local form tolerance increases as the actual local size of the feature departs from MMC toward LMC. There is no perfect form boundary requirement at LMC.
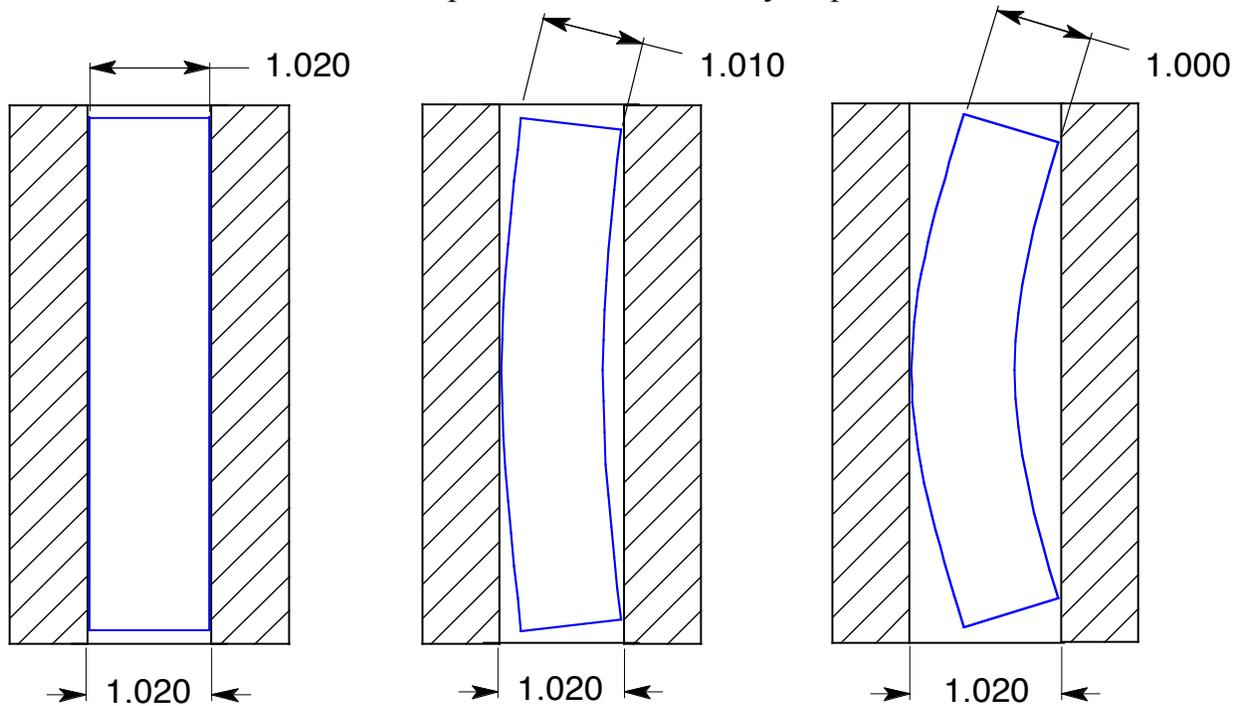
Figure 3-29A The form tolerance increases as the actual local size of the feature departs from MMC toward LMC

If a cylindrical shaft Ø1.000-1.020 is produced at exactly Ø1.020, it must be perfectly straight and perfectly round. If the shaft is produced at Ø1.010, it may be bowed or out of round or a combination of both by as much as .010. If the shaft is produced at Ø1.00, it may be bowed or out of round by as much as .020. Form tolerance, determined by Rule #1, comes from the difference between the actual size of a feature and its maximum material condition boundary.

[1]Cogorno, Gene R., *Geometric Dimensioning and Tolerancing for Mechanical Design, Second Edition*, McGraw-Hill, New York, 2011, p. 36.

Ø 1.000-1.020

☐── | .006

.006
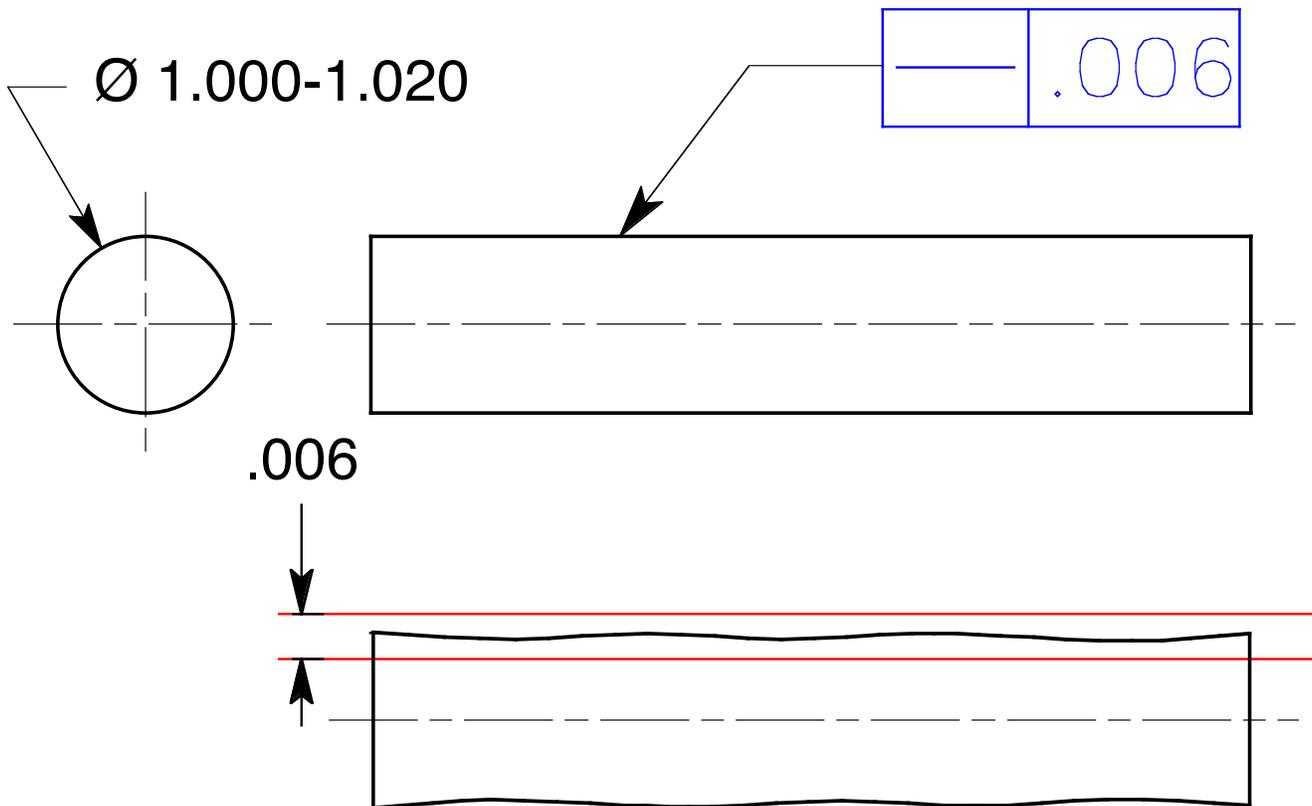
Figure 3-29B Form refined with a straightness of a surface tolerance

Fig. 3-29B illustrates the Ø1.000-1.020 shaft with a straightness refinement of .006. If the shaft is produced at the most likely size of Ø1.010, it must be straight within .006 specified by the straightness control. However, if it is produced at Ø1.015 or greater, the form is controlled by Rule #1. Maximum material condition, 1.020, minus the actual size, 1.015, equals a difference of .005. Consequently, the shaft must be straight and round within .005. As the diameter of the shaft increases towards maximum material condition, the form tolerance decreases. Both Rule #1 and the straightness tolerance control form. The form tolerance is determined by the tighter of the two types of controls.

Ø.500-.505 Ⓘ   ☐── | .015
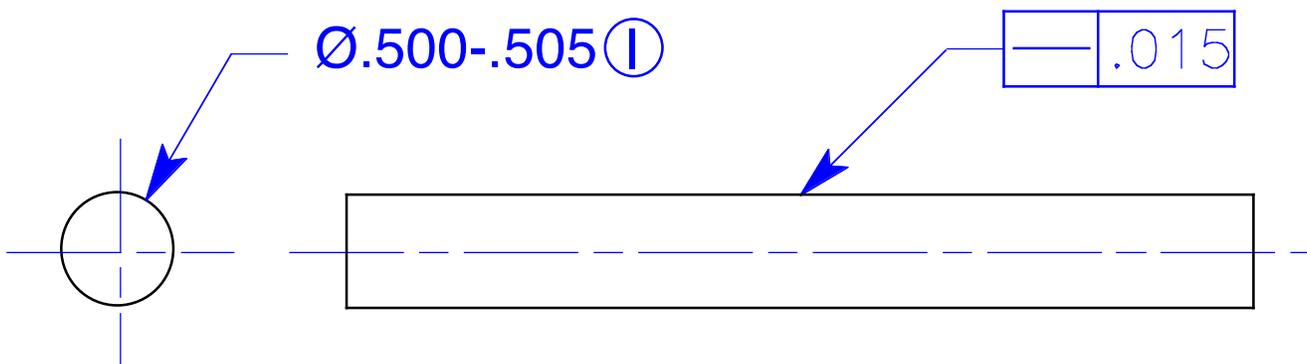
Figure 3-30 Independency symbol

Perfect form at MMC is not required if it is desired to allow the surface(s) of a feature to exceed the boundary of perfect form at MMC. In such cases, the independency symbol, circle I, may be placed next to the appropriate dimension or notation. However, a supplementary form tolerance(s) may be required to limit excessive variations of form as shown in Figure 3-30. If the shaft in Fig. 3-30 did not have the circle I following the dimension, the maximum straightness tolerance would be .005.

Rule #1 does not apply to stock or to features subject to free state variation in the unrestrained condition. When the word stock is specified on a drawing, it indicates bar, plate, sheet, etc. as it comes from the supplier. Stock items are manufactured to industry or government standards and are not controlled by Rule #1. Stock is used as is, unless otherwise specified by a geometric tolerance or a note. Rule #1 does not apply to parts that are flexible and are to be measured in their free state.

Rule #1 is a very convenient form control because it automatically applies to every regular feature of size. The application of Rule #1 insures that an external feature of size will always mate with its counterpart internal feature of size that shares the same maximum material condition.