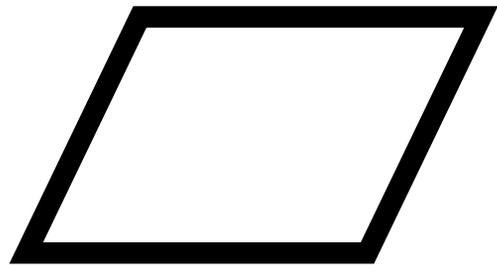# Tolerances of Form(Form Errors)
for a Hydraulic valve

Four types of Form errors must be within a restricted **limit** in hydraulic valve parts. The circularity, straightness and cylindricity are very critical to quality in spool and spool bore in valve body. The flatness is very important to the faces of valve body sections in a sectional DC valve.
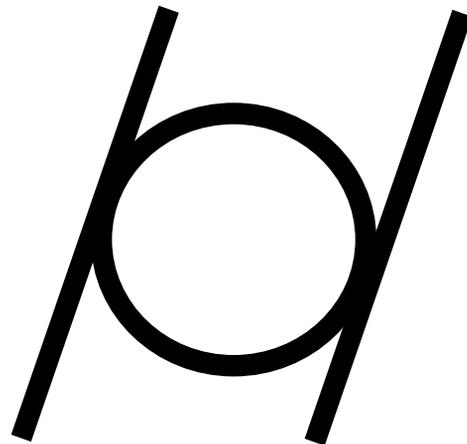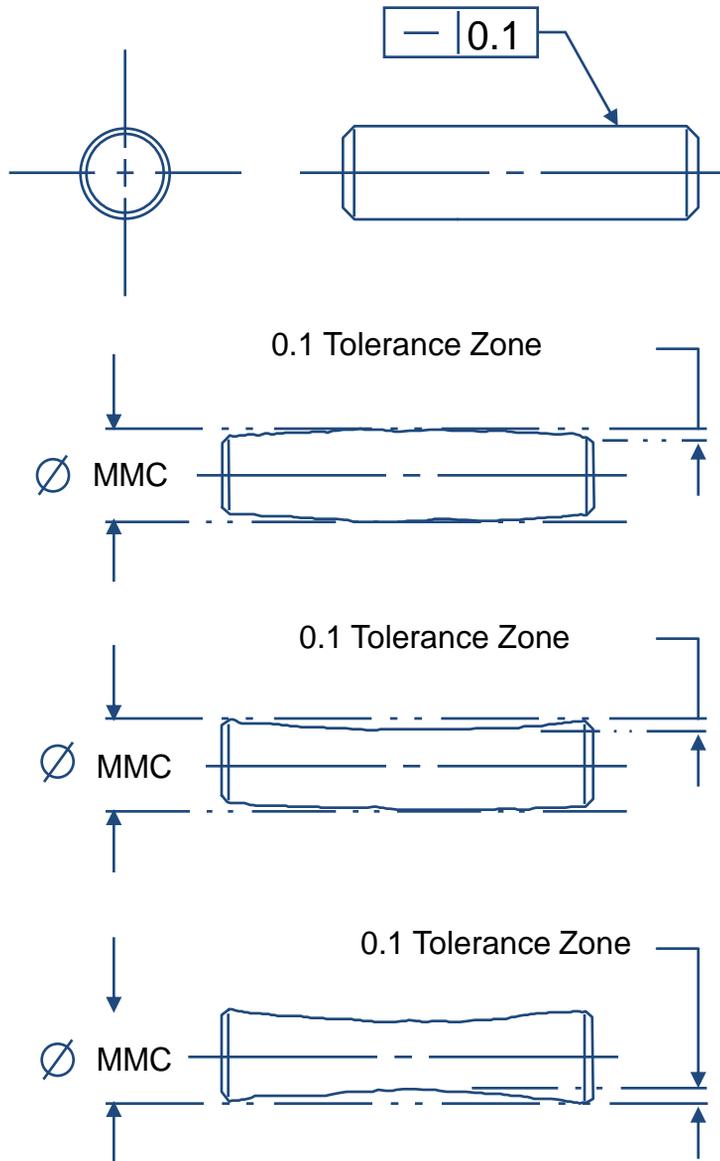
Straightness

Flatness
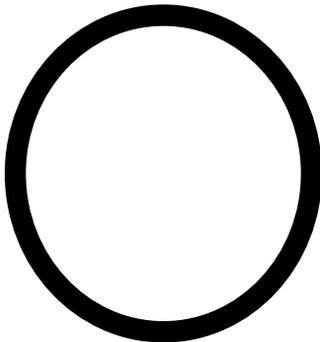
Circularity

Cylindricity

Straightness (Surface Elements)

In this example each longitudinal element of the surface must lie within a tolerance zone defined by two parallel lines separated by the specified tolerance value. The feature must be within the limits of size and the boundary of perfect form at MMC. Any barreling or waisting of the feature must not exceed the size limits of the feature.
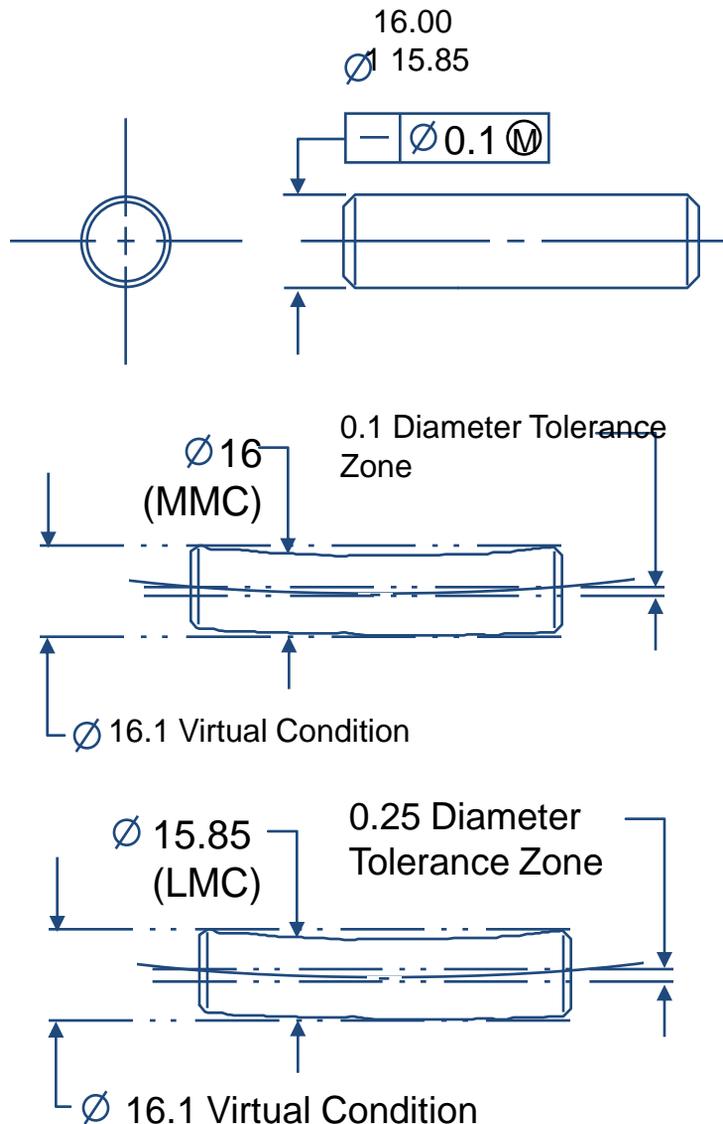
Straightness (RFS)

−	⌀ 0.1

**0.1 Diameter
Tolerance Zone**

⌀ MMC
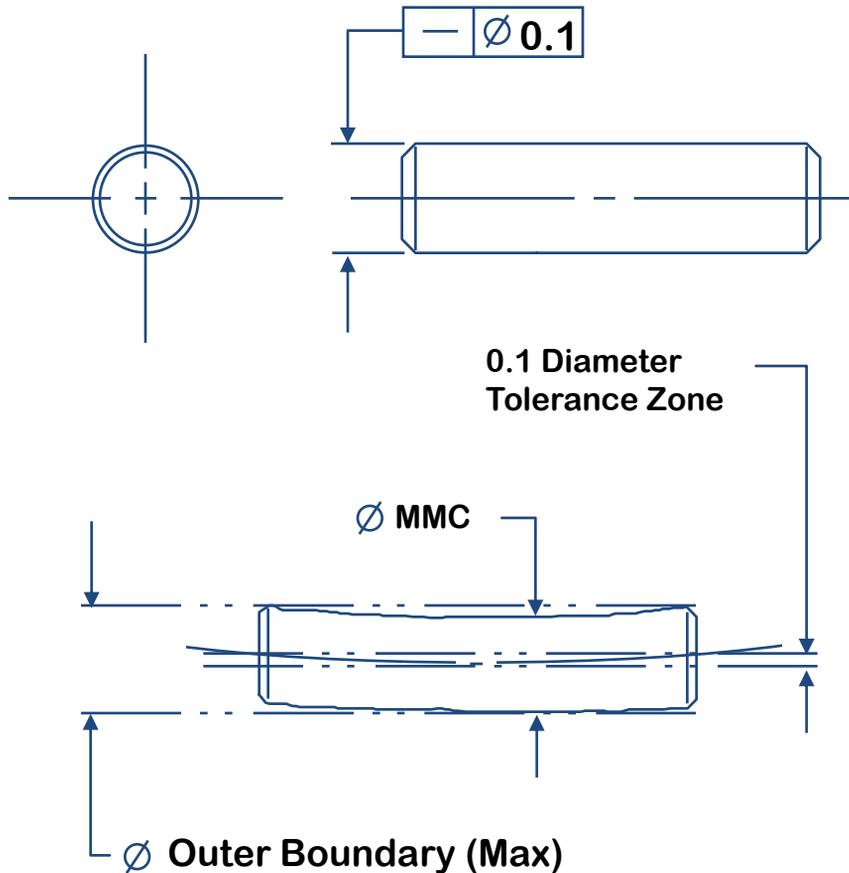
⌀ Outer Boundary (Max)

Outer Boundary = Actual Feature Size + Straightness Tolerance

In this example the derived median line of the feature's actual local size must lie within a tolerance zone defined by a cylinder whose diameter is equal to the specified tolerance value regardless of the feature size. Each circular element of the feature must be within the specified limits of size. However, the boundary of perfect form at MMC can be violated up to the maximum outer boundary or virtual condition diameter.

Straightness (MMC)

16.00
Ø 15.85

$-$ | Ø0.1 Ⓜ

Ø16
(MMC)

0.1 Diameter Tolerance Zone

Ø 16.1 Virtual Condition

Ø 15.85
(LMC)

0.25 Diameter Tolerance Zone

Ø 16.1 Virtual Condition

Virtual Condition = MMC Feature Size + Straightness Tolerance

In this example, the derived median line of the feature's actual local size must lie within a tolerance zone defined by a cylinder whose diameter is equal to the specified tolerance value at MMC. As each circular element of the feature departs from MMC, the diameter of the tolerance cylinder is allowed to increase by an amount equal to the departure from the local MMC size. Each circular element of the feature must be within the specified limits of size. However, the boundary of perfect form at MMC can be violated up to the virtual condition diameter.

Circularity (Roundness)
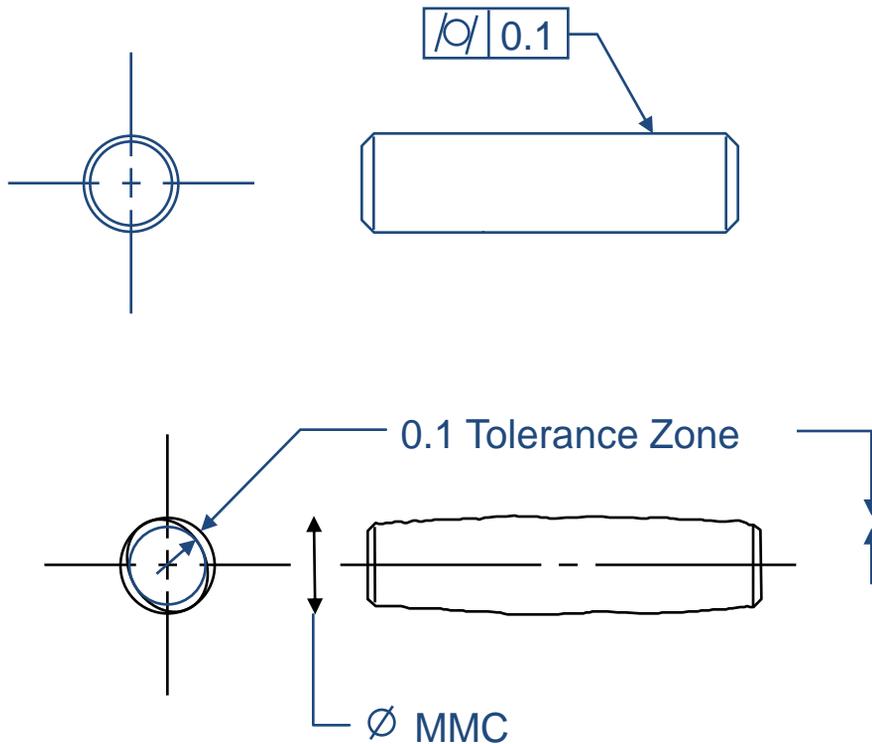
⌀ 0.1

⌀ 0.1

90°

90°
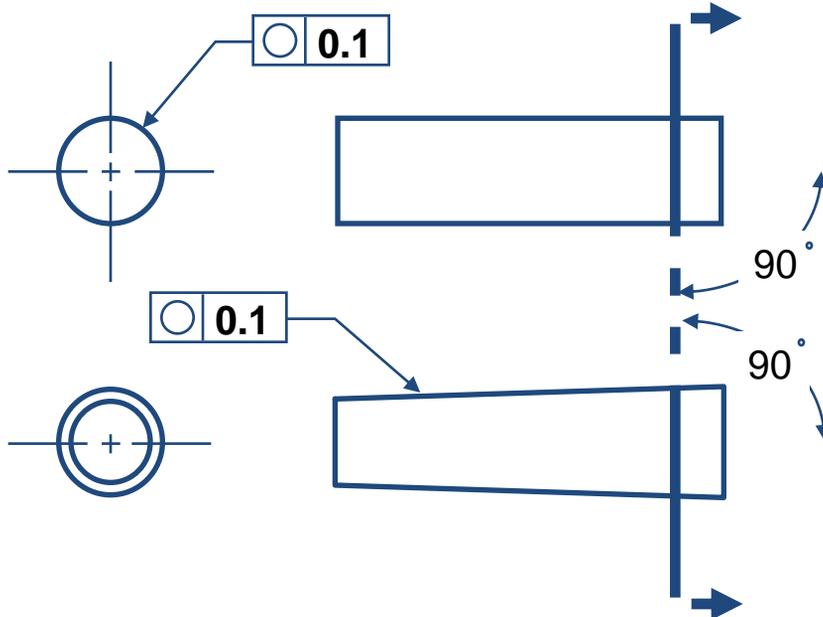
0.1 Wide Tolerance Zone
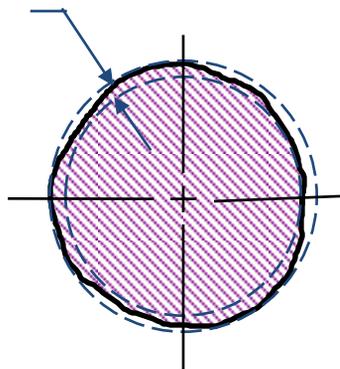
In this example each circular element of the surface must lie within a tolerance zone defined by two concentric circles separated by the specified tolerance value. All points on the surface must lie within the limits of size <u>and</u> the circularity limit.

Circularity is the condition of a surface where all points of the surface intersected by any plane perpendicular to a common axis are equidistant from that axis. The circularity tolerance must be less than the size tolerance

Cylindricity

⌭ 0.1
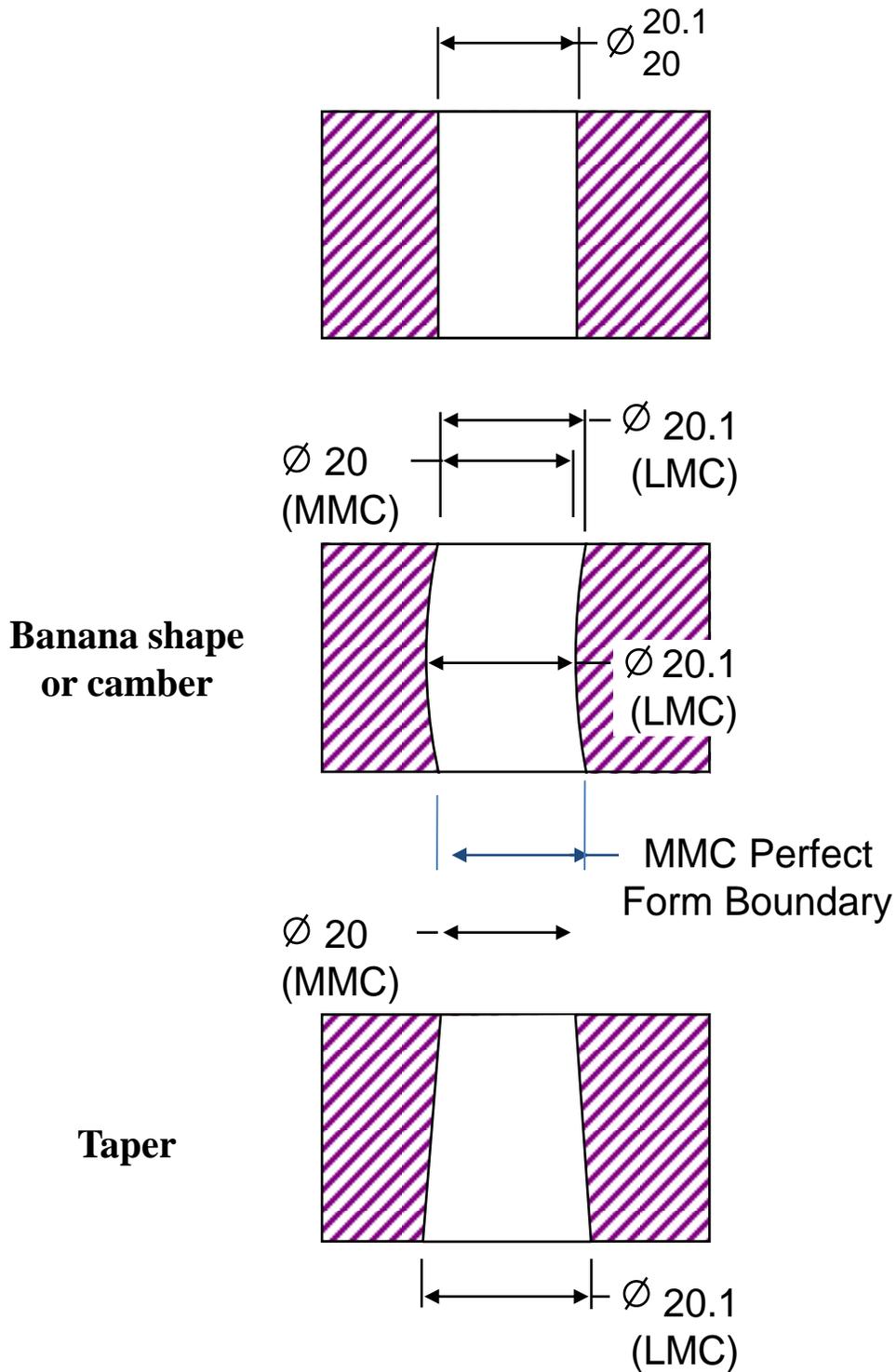
0.1 Tolerance Zone

Ø MMC

Barrel shape

In this example the entire surface must lie within a tolerance zone defined by two concentric cylinders separated by the specified tolerance value. All points on the surface must lie within the limits of size <u>and</u> the cylindricity limit.

Cylindricity is the condition of a surface of revolution in which all points are equidistant from a common axis. Cylindricity is a composite control of form which includes circularity (roundness), straightness, and taper of a cylindrical feature.

Extreme Variations of Form Allowed By

Size Tolerance for spool bore on valve body
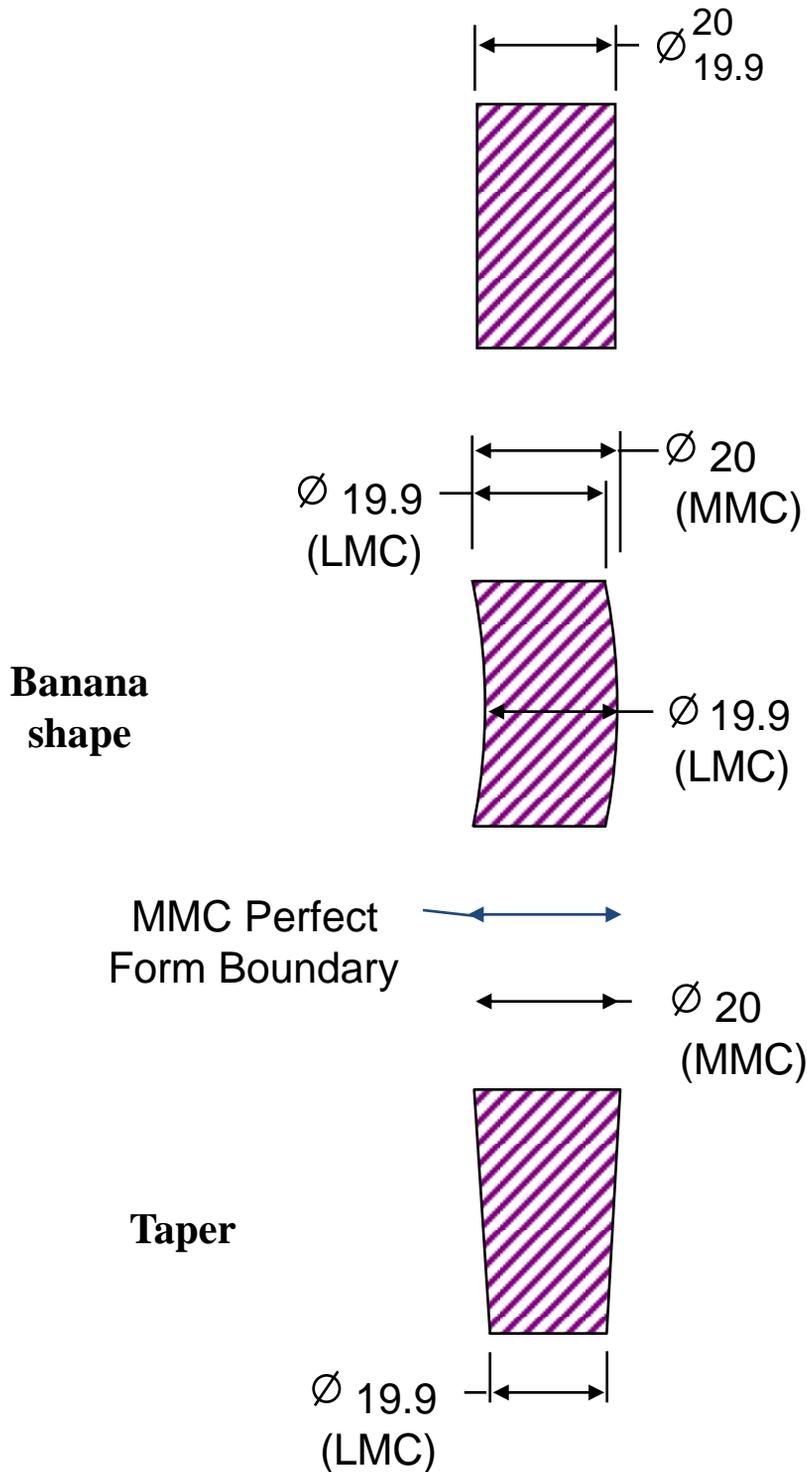
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Ø 20.1 / 20

Ø 20 (MMC)

Ø 20.1 (LMC)

Ø 20.1 (LMC)

MMC Perfect Form Boundary

Banana shape or camber

Ø 20 (MMC)

Taper

Ø 20.1 (LMC)

Extreme Variations of Form Allowed By Size Tolerance for spool OD

$\varnothing\,{}^{20}_{19.9}$

$\varnothing\,20$ (MMC)

$\varnothing\,19.9$ (LMC)

Banana shape

$\varnothing\,19.9$ (LMC)

MMC Perfect Form Boundary

$\varnothing\,20$ (MMC)

Taper

$\varnothing\,19.9$ (LMC)

Extreme Variations of Form Allowed By Size Tolerance

$\emptyset \; {20.1 \atop 20}$

$\emptyset \; {20 \atop 19.9}$

$\emptyset \; 20$ (MMC)

$\emptyset \; 20.1$ (LMC)

$\emptyset \; 20.1$ (LMC)

$\emptyset \; 19.9$ (LMC)

$\emptyset \; 20$ (MMC)

$\emptyset \; 19.9$ (LMC)

MMC Perfect Form Boundary

$\emptyset \; 20$ (MMC)

$\emptyset \; 20$ (MMC)

$\emptyset \; 20.1$ (LMC)

$\emptyset \; 24.9$ (LMC)

Flatness

$\square$

0.1

25 +/-0.25

0.1 Tolerance Zone

0.1 Tolerance Zone

24.75 min

25.25 max
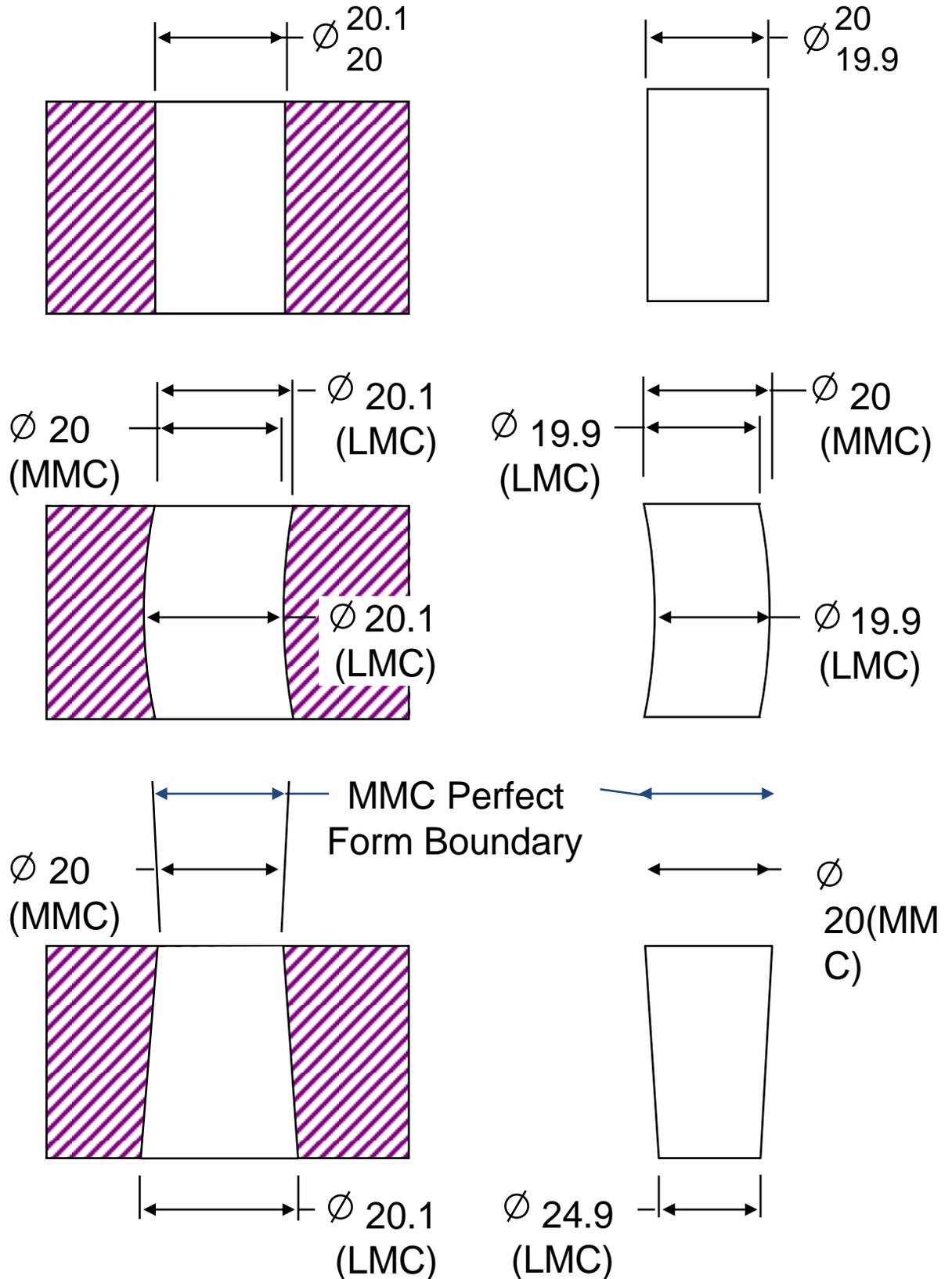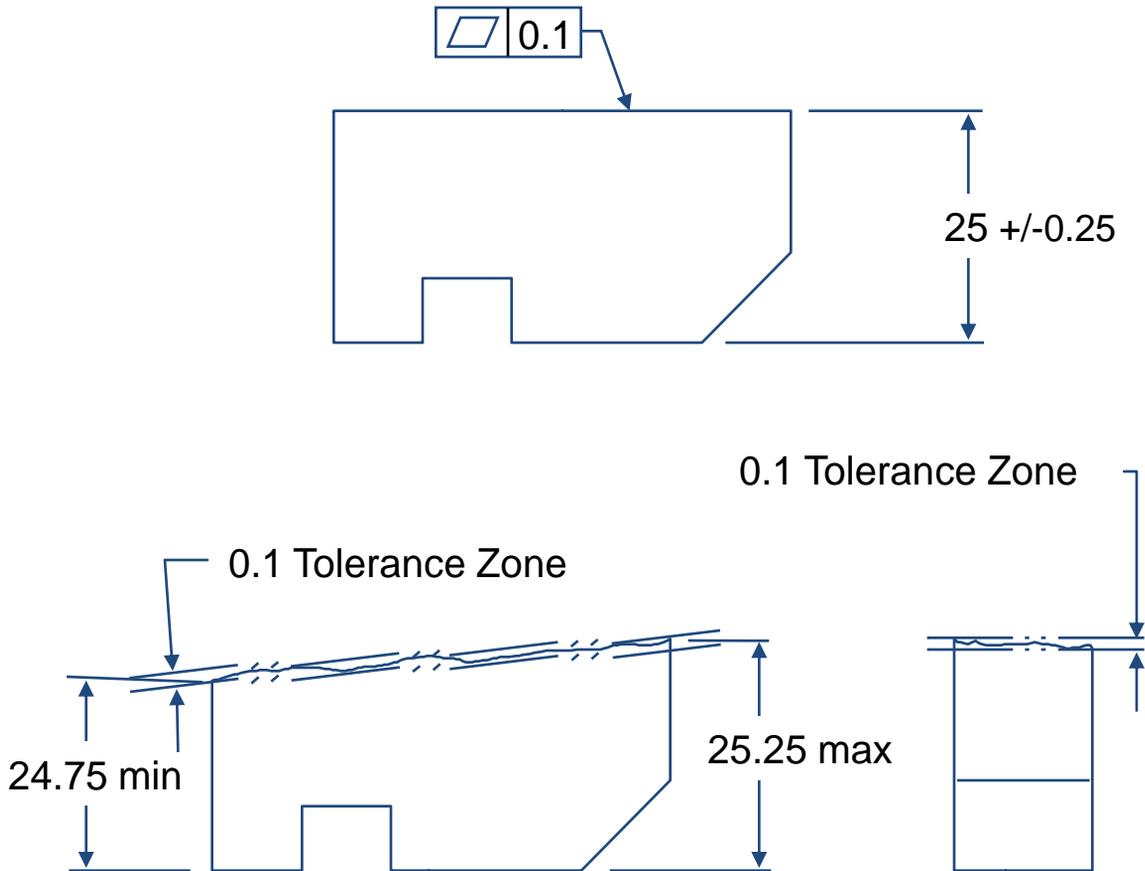
In this example the entire surface must lie within a tolerance zone defined by two parallel planes separated by the specified tolerance value. All points on the surface must lie within the limits of size <u>and</u> the flatness limit.

Flatness is the condition of a surface having all elements in one plane. Flatness must fall within the limits of size. The flatness tolerance must be less than the size tolerance.