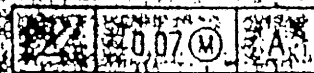


Geometric tolerances A workshop guide

Supplementary to Standard 51-3-5



datum
modifier
tolerance
symbol

Form no. 01.2783

Issued by Standards Department, April 1980

VENDOR

INTRODUCTION

This guide is intended for use in Production and Quality areas. It illustrates and interprets the Geometric Tolerancing Symbols used on drawings.

More detailed instructions for designers are given in 51-3-5 'Geometric Tolerancing'.

RELATED STANDARDS

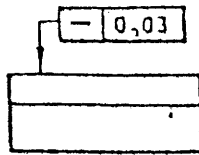
- 51-3-3 Glossary of Drawing Practice Terms
- 51-3-4 Engineering Drawing Practice
- 51-3-5 Geometric Tolerancing
- 51-3-6 Datums

GEOMETRIC TOLERANCING SYMBOLS

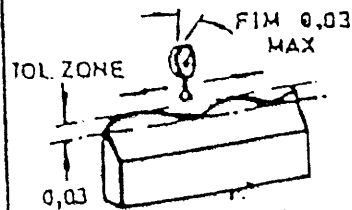
TYPE OF TOL.		CHARACTERISTIC	SYMBOL	PAGE	
FORM	SINGLE FEATURES	STRAIGHTNESS 直线度	—	2	
		FLATNESS 平面度	▭	3	
		ROUNDNESS 圆度	○	4	
		CYLINDRICITY 圆柱度	⊘	5	
		SINGLE OR RELATED	PROFILE OF A LINE 轮廓厚度	⌒	6
			PROFILE OF A SURFACE 轮廓圆度	⊖	7
TOLERANCES OF ORIENTATION	RELATED FEATURES	PARALLELISM 平行度	//	8	
		PERPENDICULARITY (SQUARENESS) 垂直度	⊥	9	
		ANGULARITY 倾斜度	∠	10	
		POSITION 位置度	⊕	11	
		COAXIALITY/CONCENTRICITY 同轴度	⊙	12	
ALIGNMENT	RELATED FEATURES	SYMMETRY 对称度	≡	13	
		RUNOUT 圆跳动	↗	14	
		TOTAL RUNOUT 总跳动	↗↘	15	
UTILIZATION SYMBOLS	DATUM 基准	▲	16		
	DATUM TARGET 基准目标	⊖	17		
	BOX DIMENSION (TRUE POSITION)	☐	18		
	PROJECTED TOLERANCE ZONE	Ⓟ	19		
	REGARDLESS OF FEATURE SIZE		20		
MAXIMUM MATERIAL CONDITION	Ⓜ	21			

STRAIGHTNESS

EXAMPLE

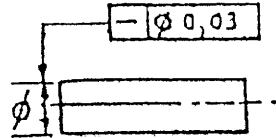


INTERPRETATION

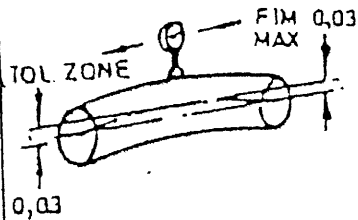


The toleranced surface must lie wholly within a tolerance zone formed by parallel lines 0,03 apart.

EXAMPLE



INTERPRETATION



The axis of the component must lie wholly within a cylindrical tolerance zone 0,03 in diameter.

NOTE

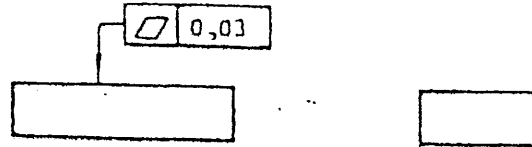
During actual measurement the component must NOT be rotated.

不可旋转

2

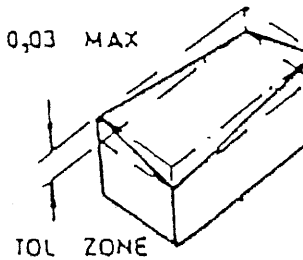
FLATNESS

EXAMPLE



INTERPRETATION

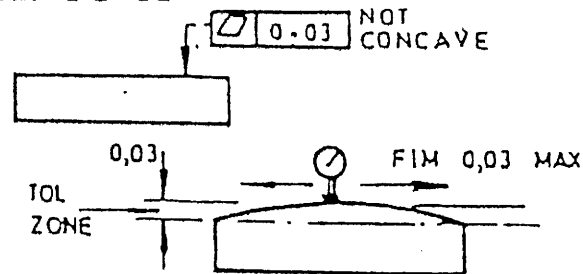
FIM 0,03 MAX



The toleranced surface must lie within a tolerance zone formed by two parallel planes 0,03 apart.

平行面
相距0.03

SPECIAL CASE



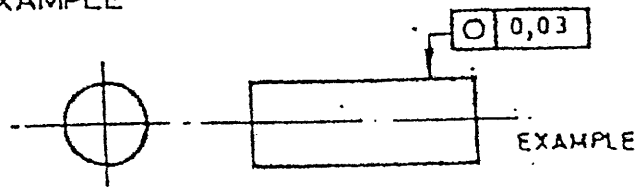
concave surface: 凹面

convex surface: 凸面

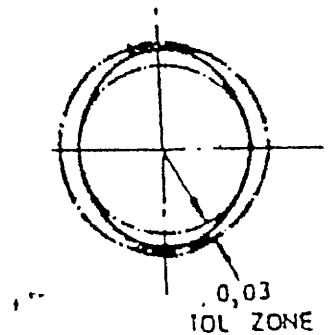
3

ROUNDNESS

EXAMPLE



INTERPRETATION



The entire periphery at the considered cross section, must lie within a tolerance zone 0,03 wide, the annular zone being formed by two concentric circles whose radii differ by 0,03.

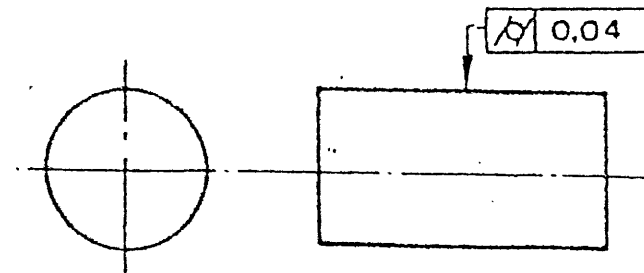
Note

Roundness can only be truly measured on a roundness measuring instrument.

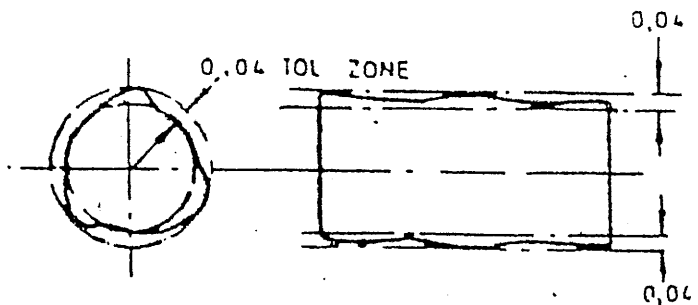
The use of vees or centres in conjunction with an indicating device always brings in factors which detract from the truth of the measurement.

CYLINDRICITY

EXAMPLE



INTERPRETATION



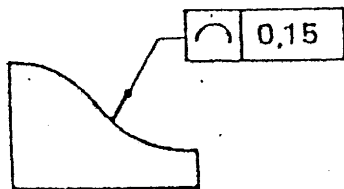
The considered surface must be contained between two coaxial cylinders, the radii of which differ by 0,04.

Note

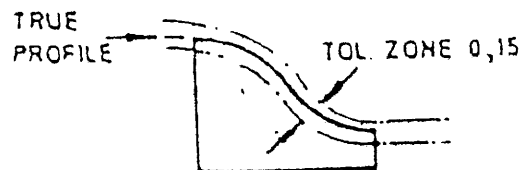
Cylindricity is difficult to measure in practice, but can be verified by measuring Roundness, Straightness and Parallelism separately.

PROFILE OF A LINE

EXAMPLE



INTERPRETATION



The line must lie wholly within a tolerance zone 0,15 wide equally disposed about the perfect profile.

The tolerance is always bilateral unless otherwise shown.

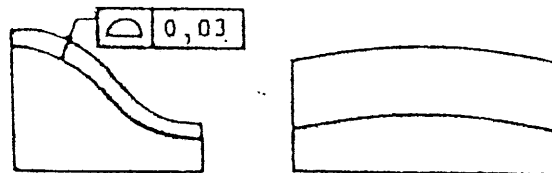
INDICATION OF UNILATERAL TOLERANCE



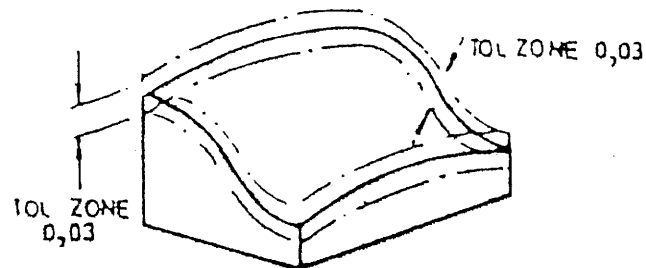
The line must lie wholly within a 0,15 tolerance zone completely disposed on the indicated side of the perfect profile.

PROFILE OF A SURFACE

EXAMPLE



INTERPRETATION



The surface must lie wholly within the 0,03 tolerance zone normal to the perfect profile.

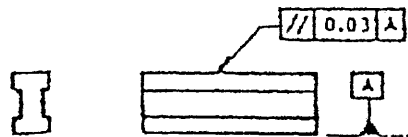
Tolerance is always bilateral unless otherwise shown.

INDICATION OF UNILATERAL TOLERANCE

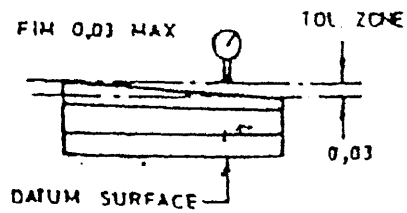
Unilateral tolerance may be indicated in the same way as for Profile of a Line, see page 6 facing.

PARALLELISM

EXAMPLE

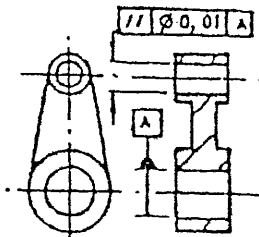


INTERPRETATION

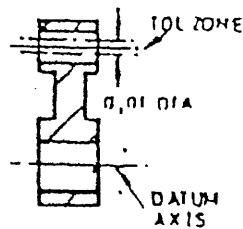


The surface must lie wholly between two planes 0,03 apart parallel with the datum surface.

EXAMPLE



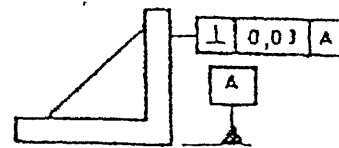
INTERPRETATION



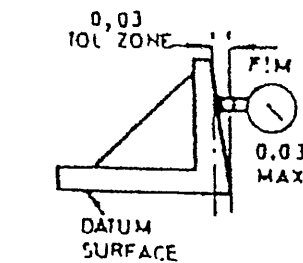
The toleranced axis must lie wholly within a cylinder 0,01 dia parallel with the Datum Axis.

PERPENDICULARITY (SQUARENESS)

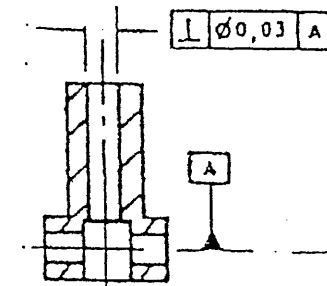
EXAMPLE



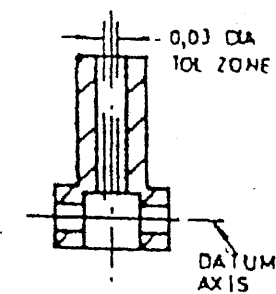
INTERPRETATION



The surface must lie wholly within two parallel planes 0,03 apart perpendicular to the Datum Surface.



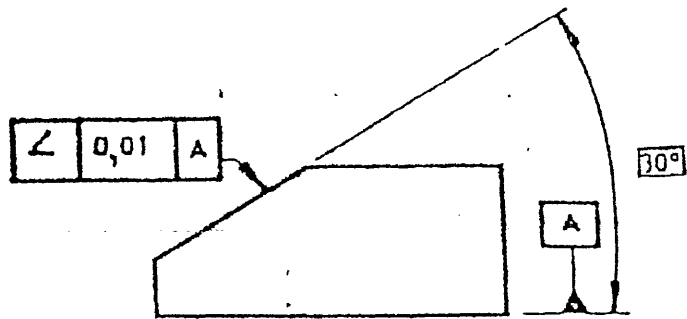
INTERPRETATION



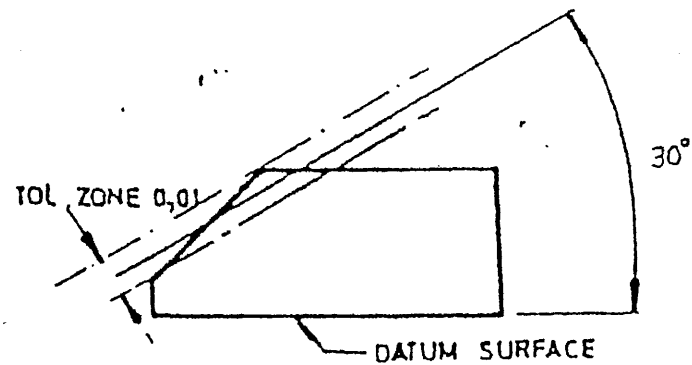
The axis of the feature must lie wholly within a cylinder 0,03 dia perpendicular to the Datum Axis.

ANGULARITY

EXAMPLE



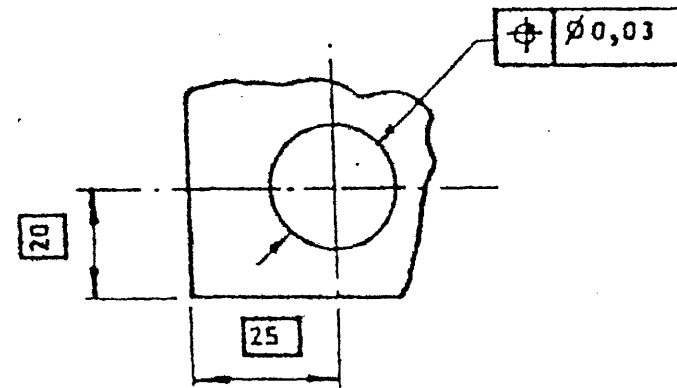
INTERPRETATION



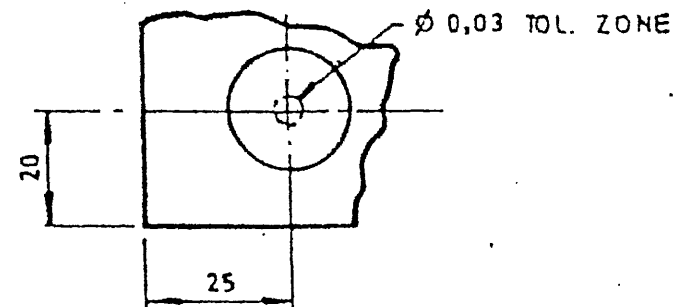
The surface must lie wholly between two parallel planes 0,01 apart at the specified angle to the Datum Surface.

POSITION

EXAMPLE



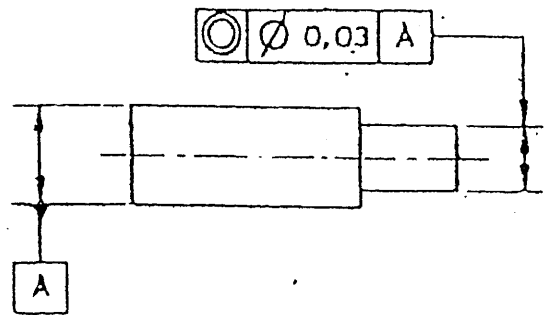
INTERPRETATION



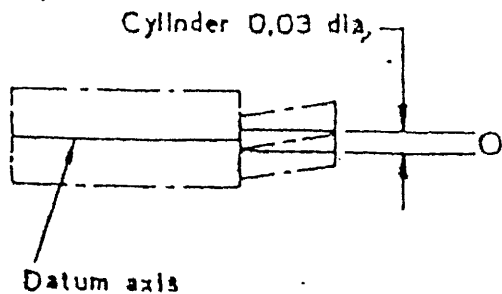
The centre of the tolerated feature must fall within a zone 0,03 dia with its centre in the exact position indicated by the Boxed Dimensions.

COAXIALITY/CONCENTRICITY

EXAMPLE



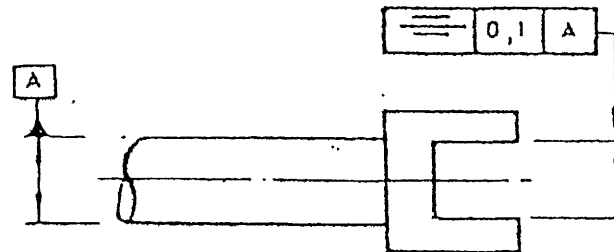
INTERPRETATION



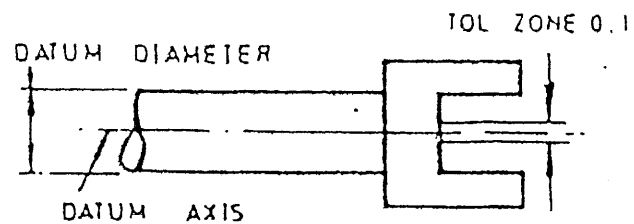
The axis of the tolerated feature must fall within a cylindrical zone 0,03 dia coaxial with the datum axis.

SYMMETRY

EXAMPLE



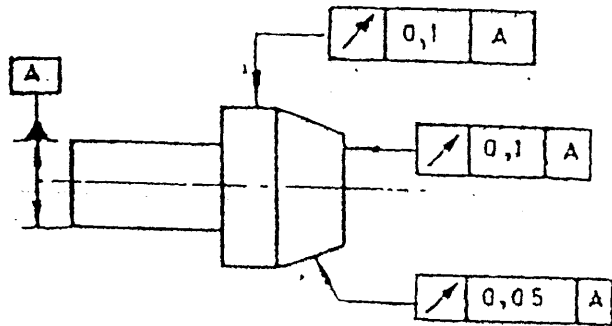
INTERPRETATION



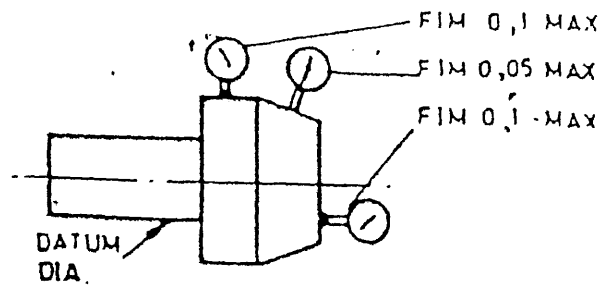
The median plane of the slot must fall between two parallel planes 0,1 apart, equidistant on either side of the datum axis.

RUNOUT

EXAMPLE



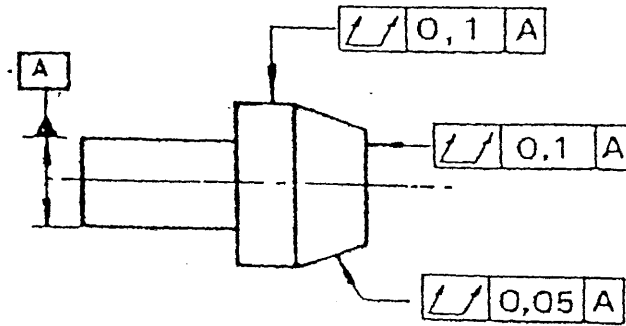
INTERPRETATION



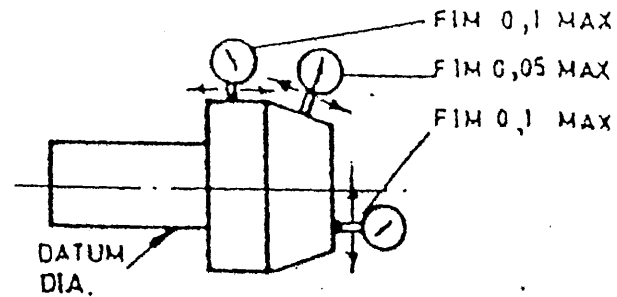
The tolerance given is the maximum permissible radial or axial variation of a position during one revolution about the Datum Axis, without axial movement.

TOTAL RUNOUT

EXAMPLE



INTERPRETATION



The tolerance given is the maximum permissible full indicator movement (FIM) during a number of revolutions about the datum axis, during which the indicator is traversed along the specified contour.

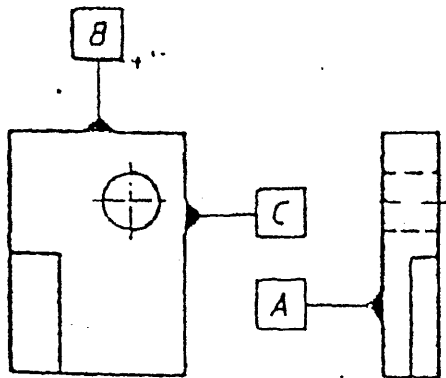
DATUMS

Datums are lines, points or planes used as a base for measurements. Generally, measurements are made from the surfaces of machines or measuring instruments in contact with a feature of the part, known as the datum feature, indicated on the drawing.

Datums may also be imaginary features, such as an axis, or a point fixed by boxed dimensions.

INDICATION OF DATUMS

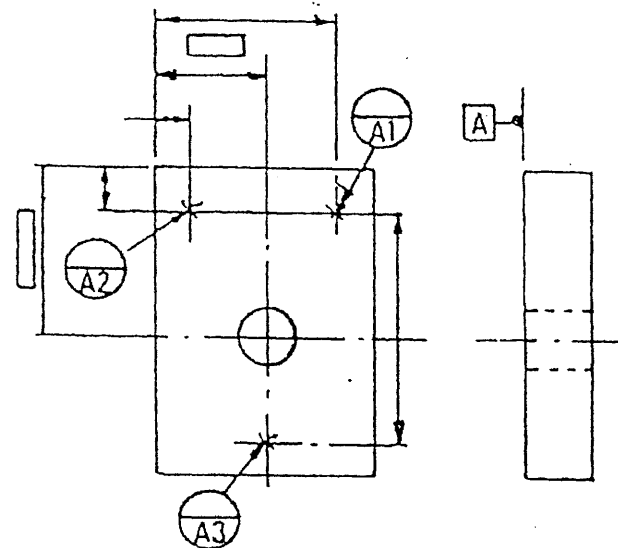
Datums are indicated by a triangle and may be identified by a reference letter as shown below.



Refer also to 51-3-6 'Datums'

DATUM TARGET

Points, lines, or limited areas on the workpiece to be used for contact with the manufacturing and inspection equipment to define the required datum or to satisfy the functional requirements.

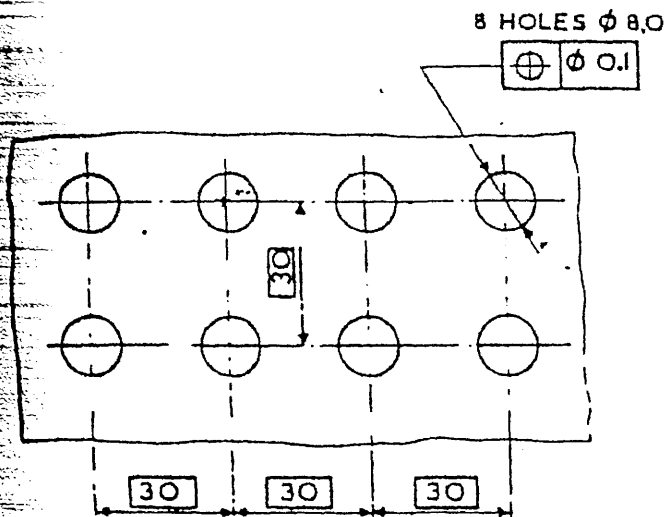


Datum Points A1, A2 & A3 establish Datum A

Refer also to 51-3-6 'Datums'

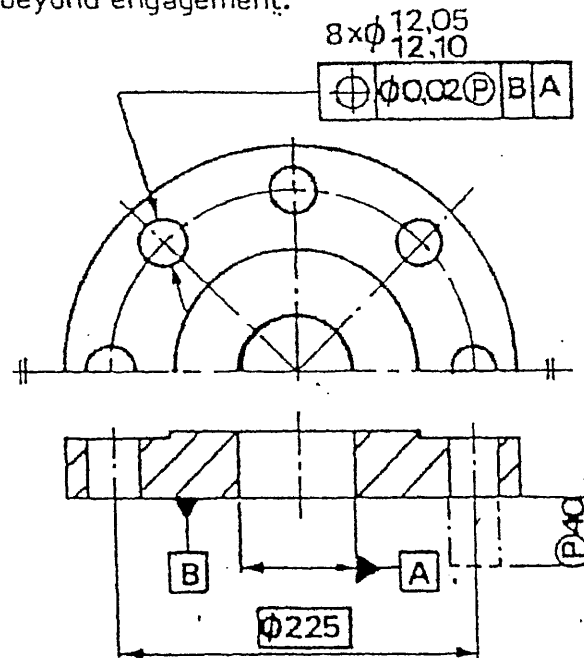
BOXED DIMENSION (TRUE POSITION)

Boxed dimensions show the true position of a hole, slot, boss, profile or other feature and are its theoretically exact location. Boxed dimensions are never individually tolerated but are always accompanied by a positional or zone tolerance of the feature to which they refer.



PROJECTED TOLERANCE

A Projected Tolerance Zone is one which is situated at some distance from the considered feature so that the projection of a fastener (or other feature) located by the considered feature (thread, press fit, hole etc.) upon installation will have adequate perpendicularity control over its length beyond engagement.



The axis of each hole shall fall within a cylinder 0.02 diameter, the axis of which is in the exact specified position and perpendicular to the datum surface; extending 40mm therefrom.

REGARDLESS OF FEATURE SIZE

Regardless of Feature Size is the condition wherein the tolerance of form or position of a feature must be met irrespective of where the feature lies within its own tolerance.

Note

All geometric tolerances are regardless of feature size unless modified by \textcircled{M} (Maximum Material Condition).

SYMBOL

There is no BSI or ISO standard symbol for Regardless of Feature Size.

MAXIMUM MATERIAL CONDITION

Maximum material condition \textcircled{M} is that condition of a part or feature wherein it contains the maximum amount of material.

For example: Minimum Size Hole
Maximum Size Shaft

The use of the \textcircled{M} principle allows an increase in the specified feature tolerance by indicating that the tolerance applies to the feature only at its maximum material condition.

The \textcircled{M} condition concept may be applied to:

Straightness	Parallelism
Perpendicularity	Angularity
Position	Coaxiality/Concentricity
Symmetry	

When applied to a feature (Hole Slot etc) but not to a plane surface or line on a surface.

The \textcircled{M} condition may be applied to a datum feature.

The \textcircled{M} condition may not be applied to:

Flatness	Roundness
Cylindricity	Runout
Profile of a Line	Total Runout
Profile of a Surface	