

Design of Process Equipment

Basics of technical drawing

Lecture

doc. Ing. Martin Juriga, PhD.
Bratislava, February 2024

Basics of technical drawing

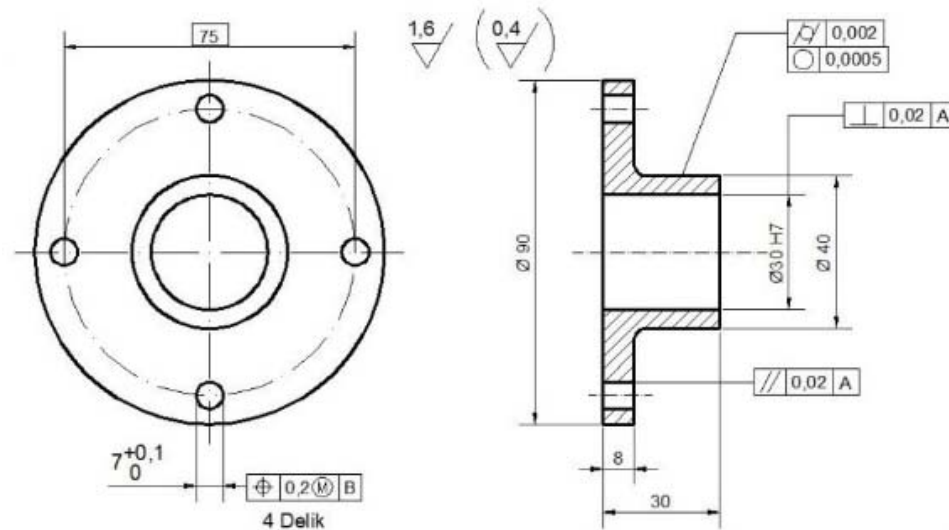
To translate a technical idea into an understandable language for others in the form of a technical drawing.

A, Unambiguous interpretation of a spatial (3D) object

How much information do I need?

View (View)
 Cut (A-A, Section)
 Detail (Detail)

B, Additive information to ensure manufacturability and functionality.

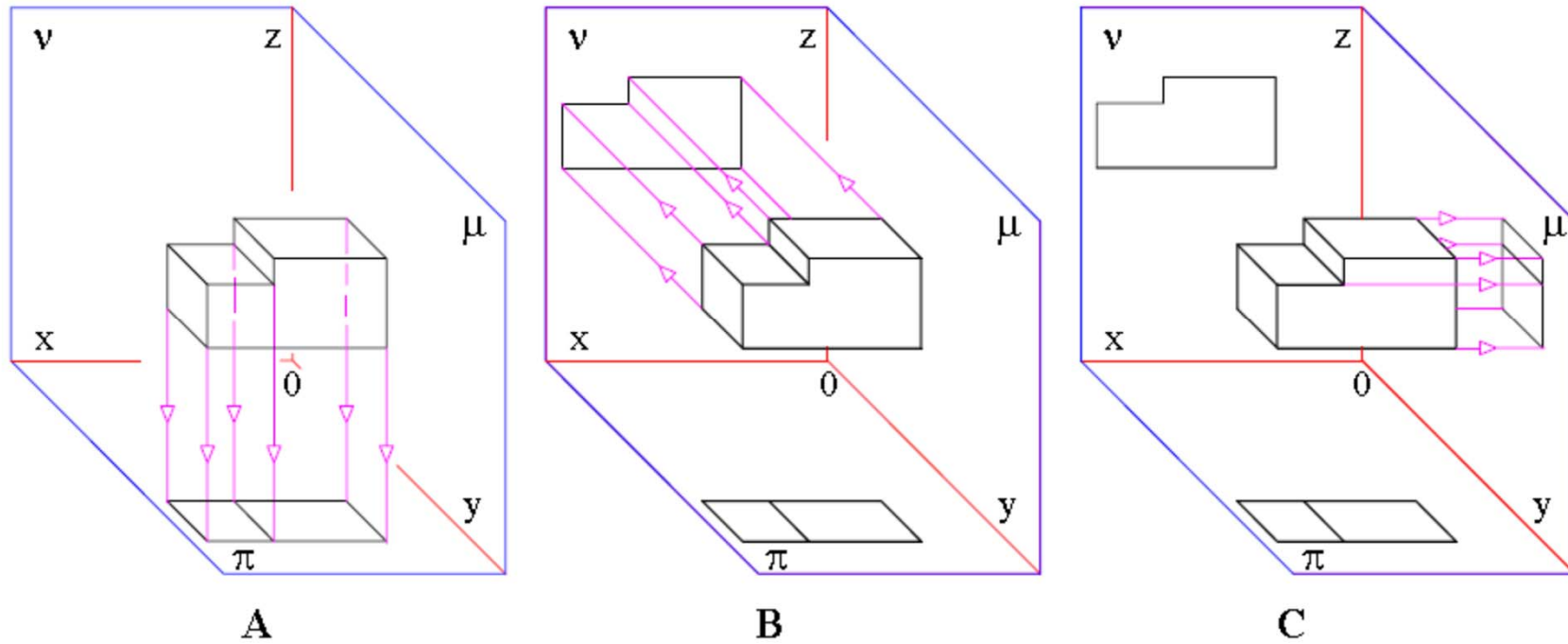


Basics of technical drawing

View

Section (A-A)

Detail

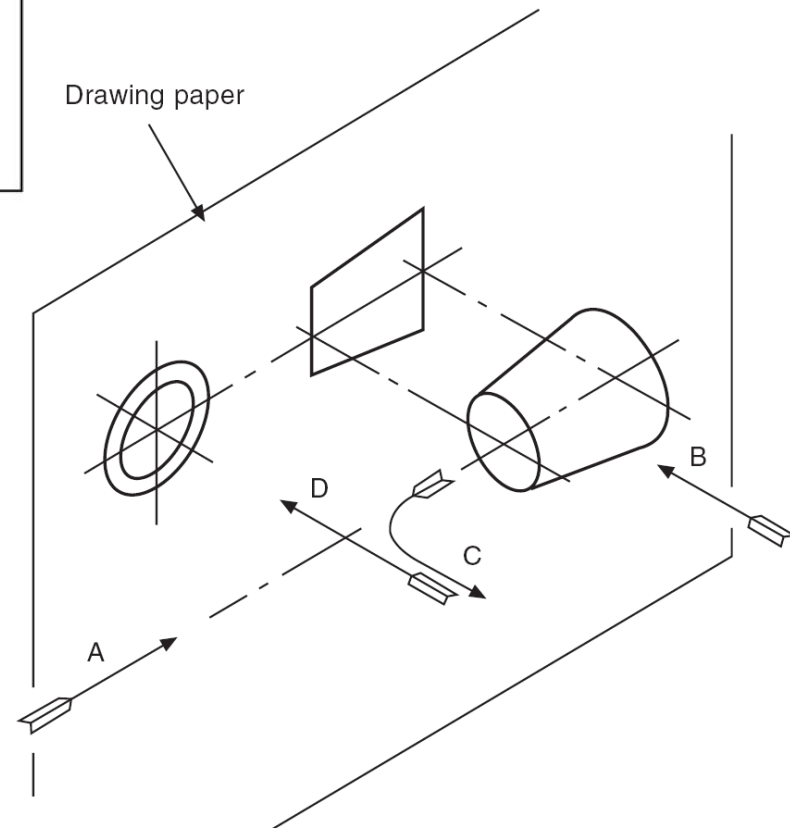
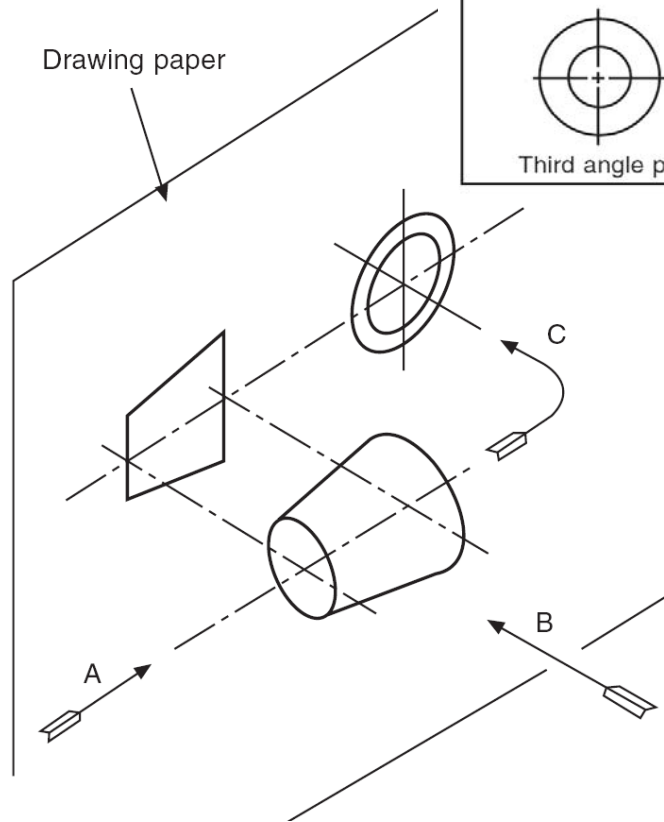
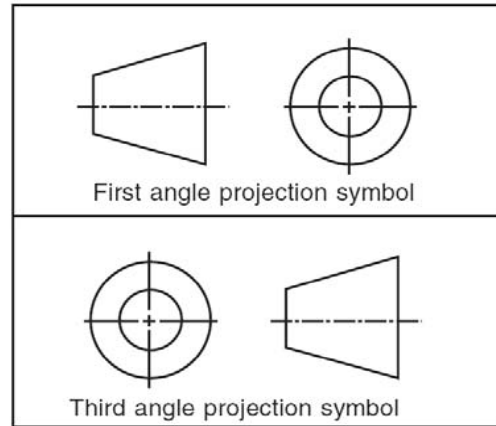


Basics of technical drawing

View

Section (A-A)

Detail

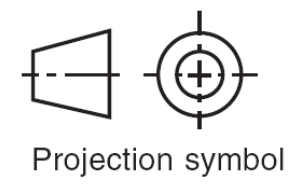
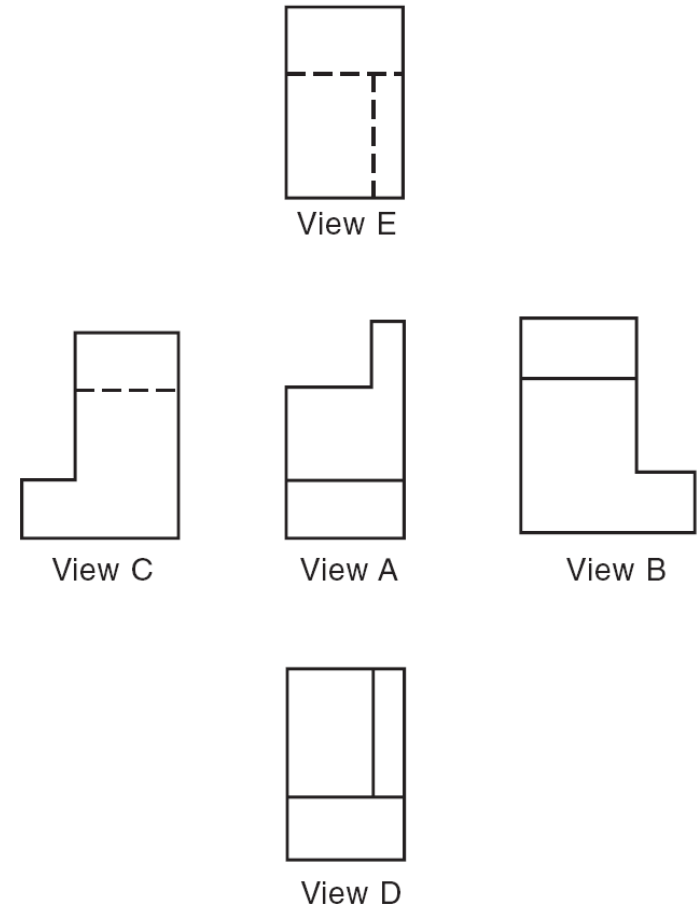
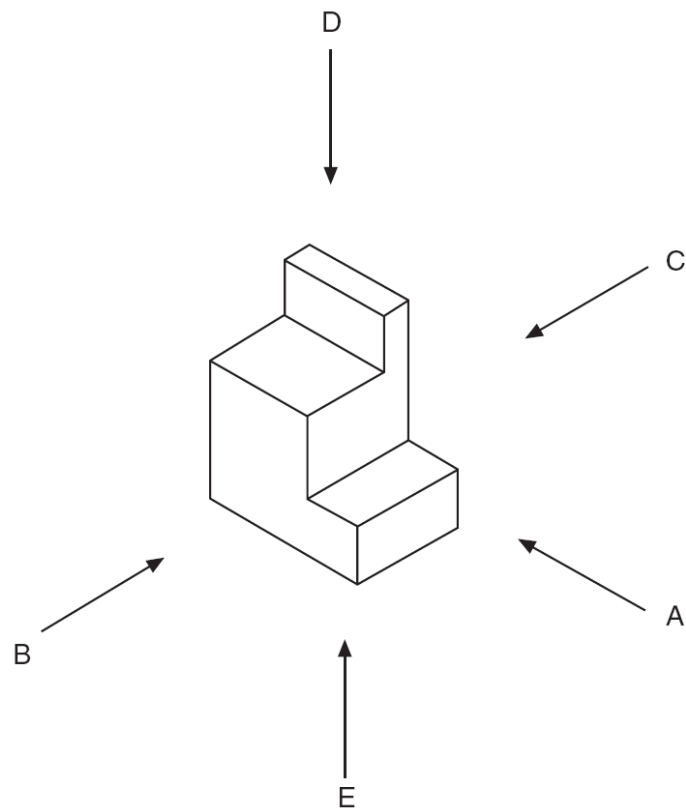


Basics of technical drawing

View

Section (A-A)

Detail



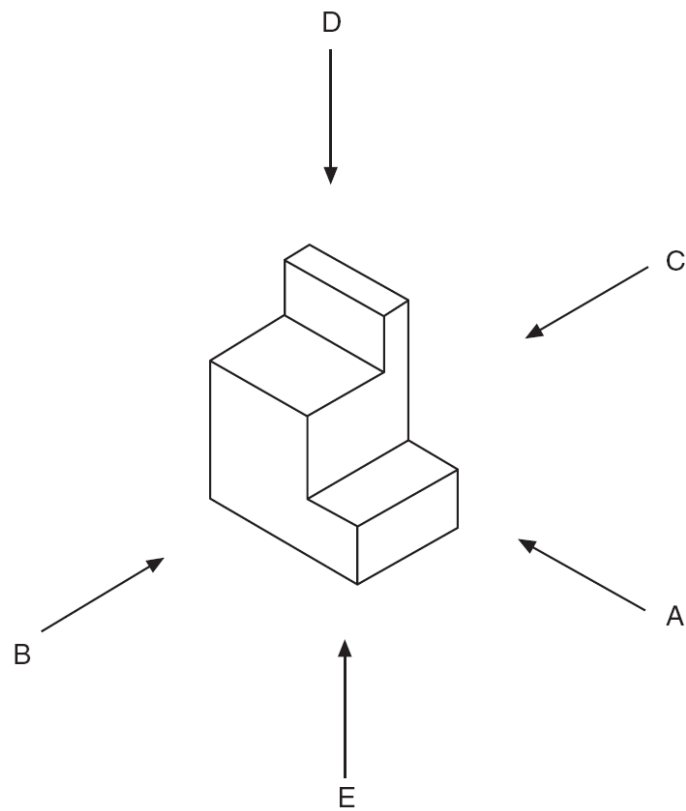
Projection symbol

Basics of technical drawing

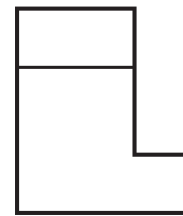
View

Section (A-A)

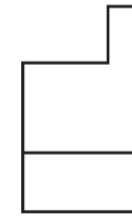
Detail



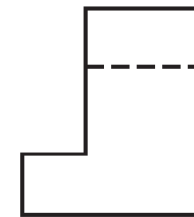
View D



View B



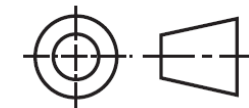
View A



View C



View E



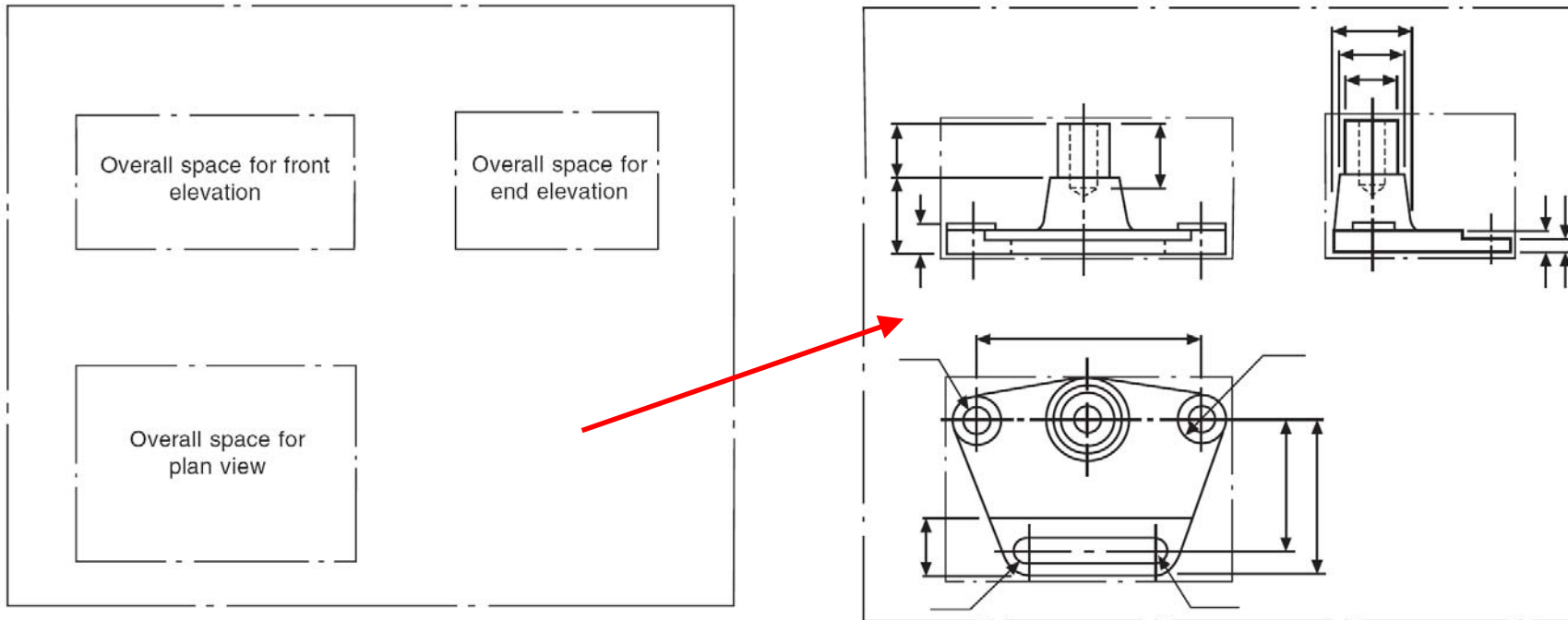
Projection symbol

Basics of technical drawing

View

Section (A-A)

Detail

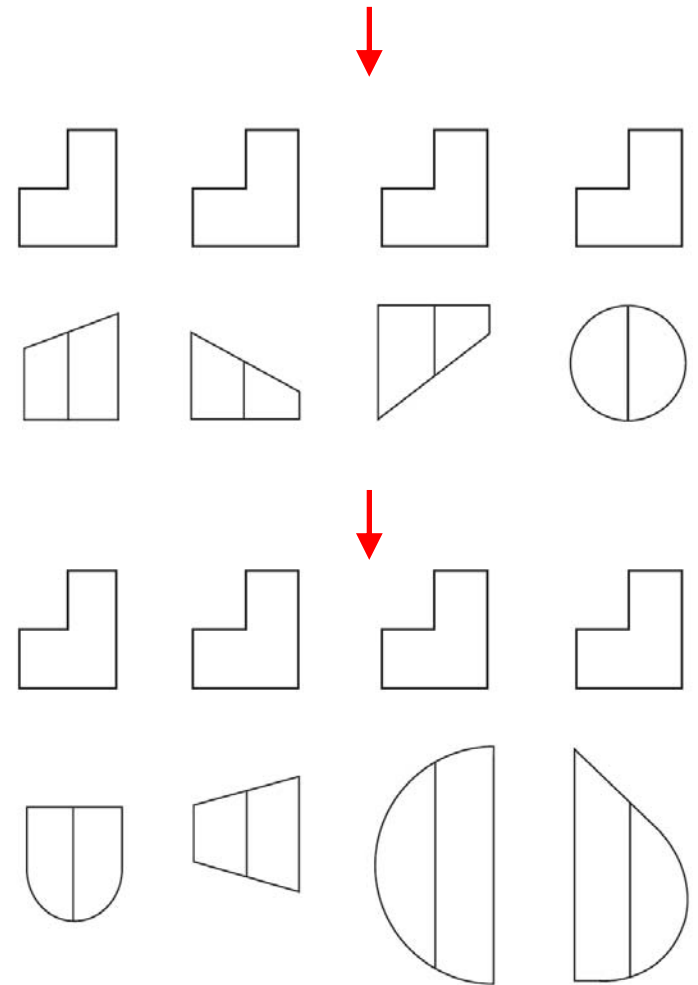
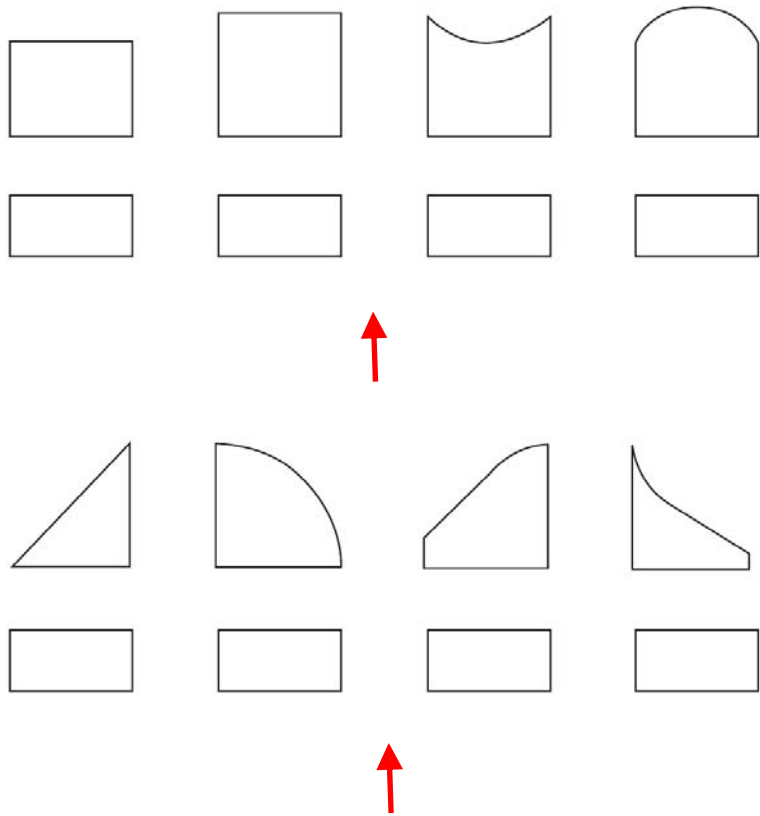


Basics of technical drawing

View

Section (A-A)

Detail

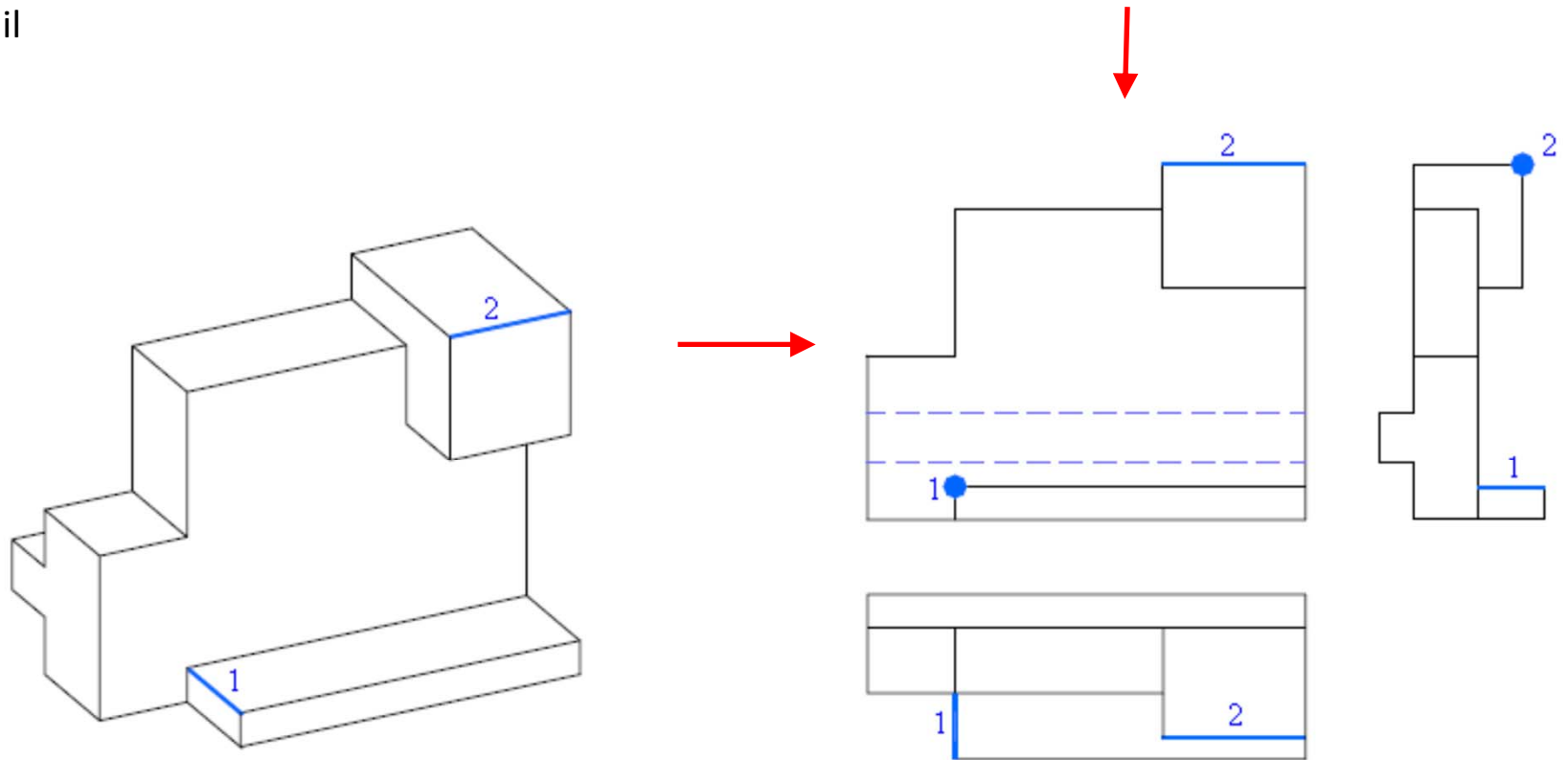


Basics of technical drawing

View

Section (A-A)

Detail

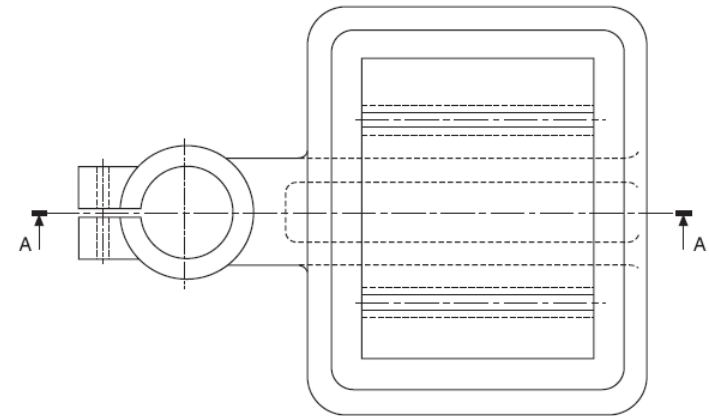
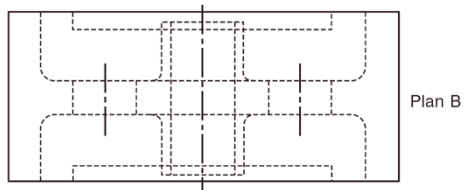
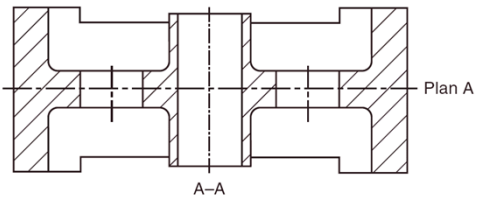
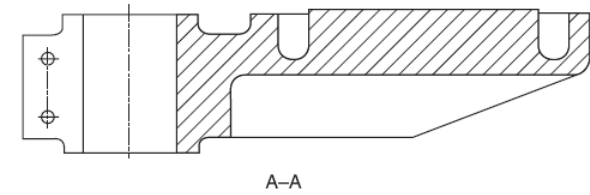
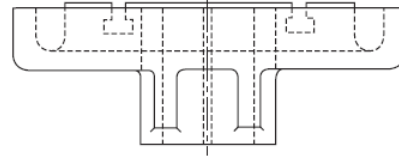
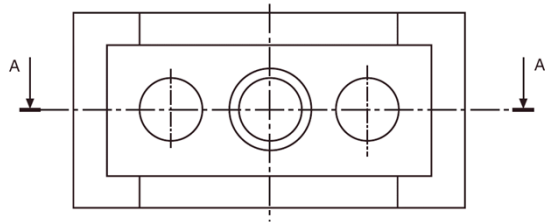


Basics of technical drawing

View

Section (A-A)

Detail

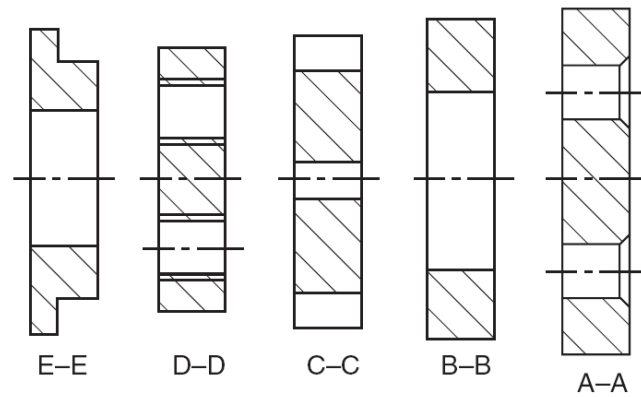
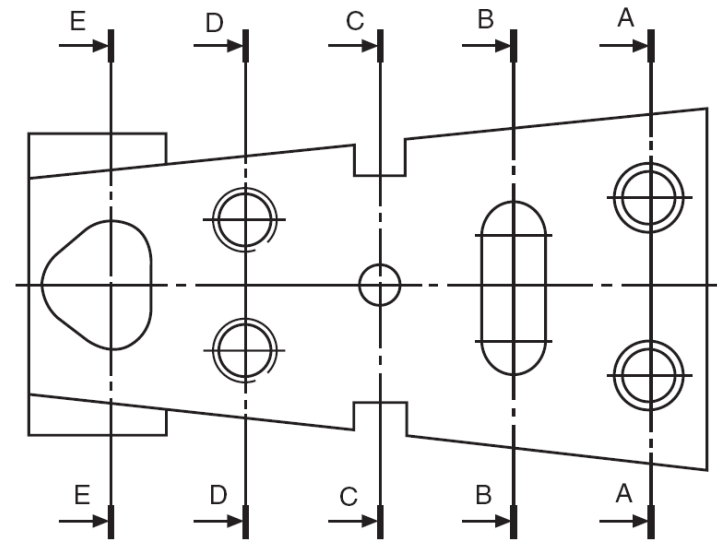
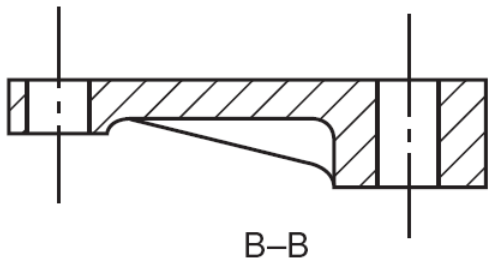
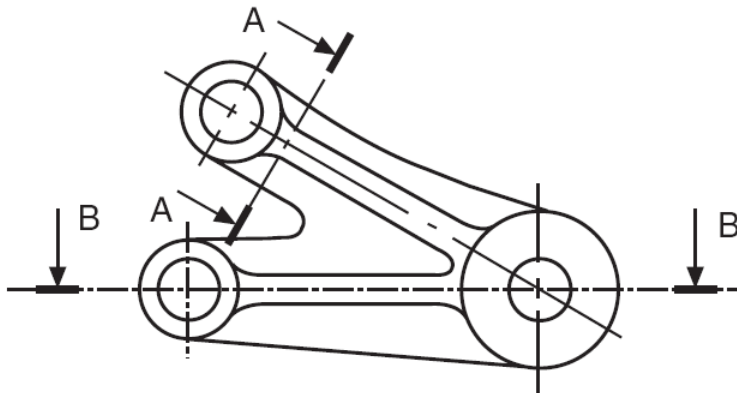


Basics of technical drawing

View

Section (A-A)

Detail

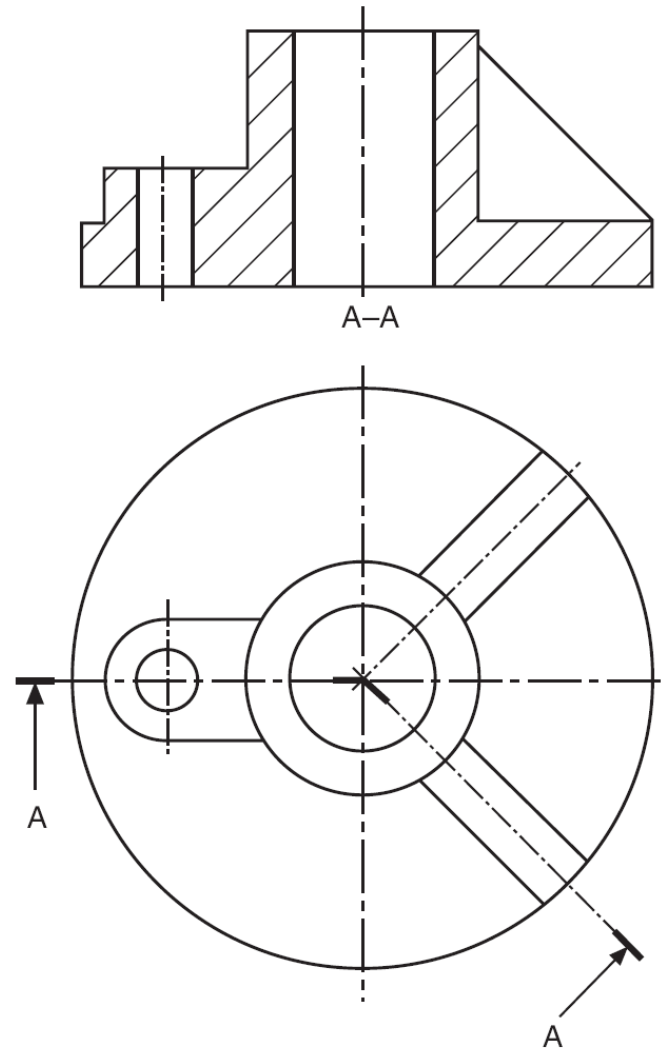
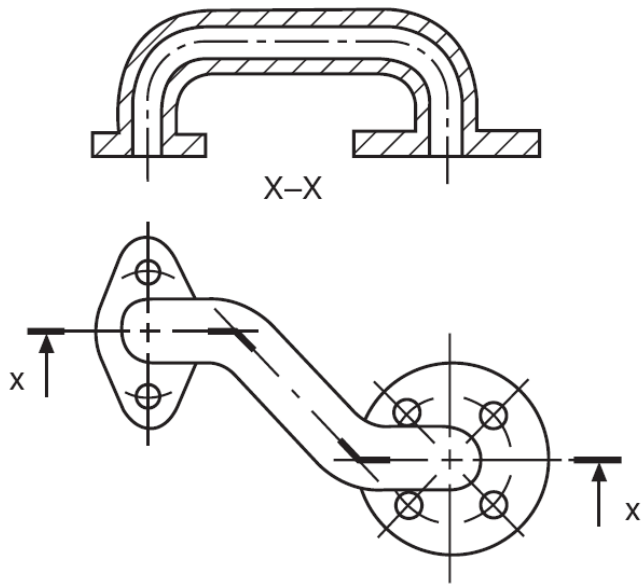


Basics of technical drawing

View

Section (A-A)

Detail

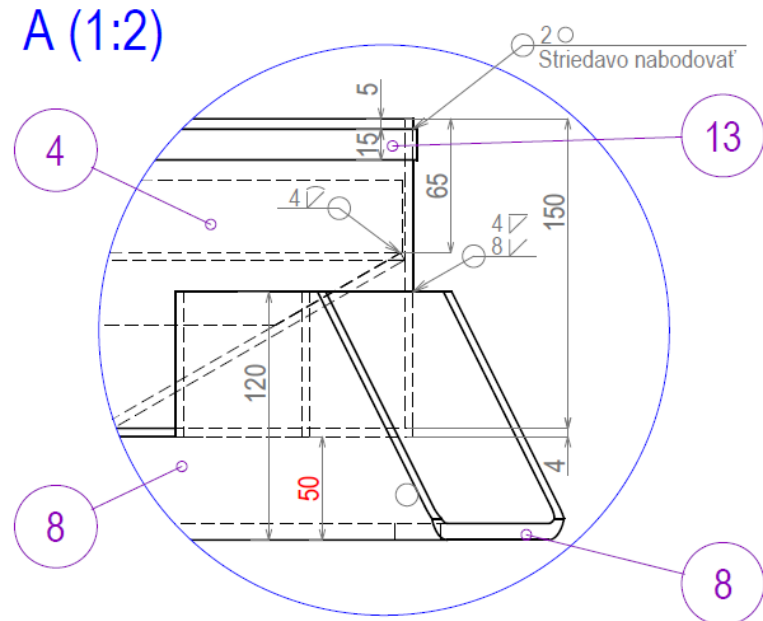
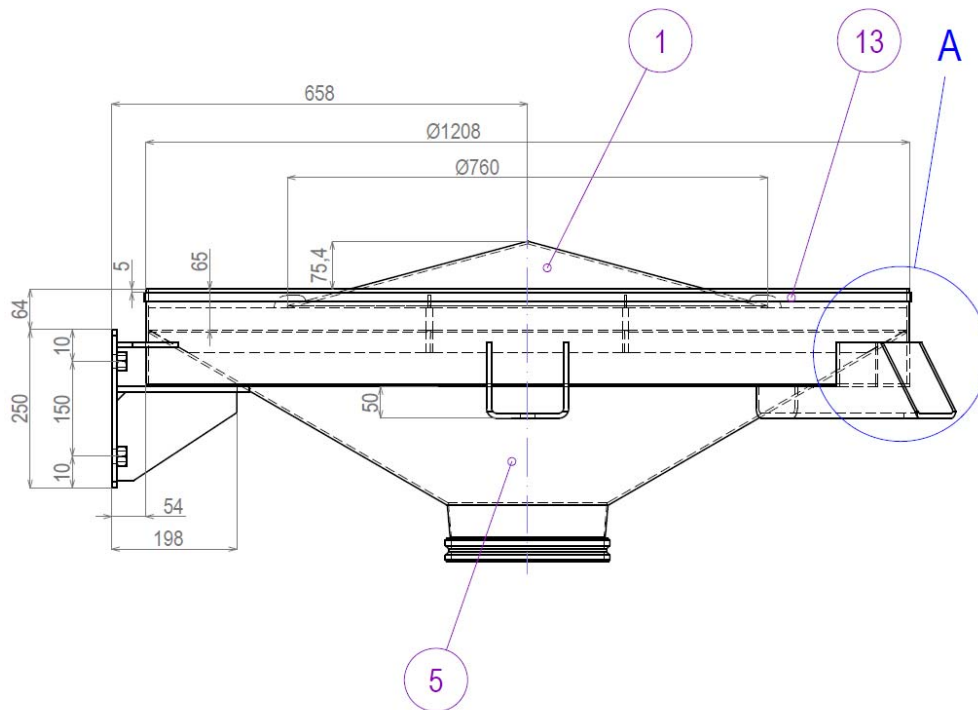


Basics of technical drawing

View

Section (A-A)

Detail



Basics of technical drawing

View

Section (A-A)

Detail

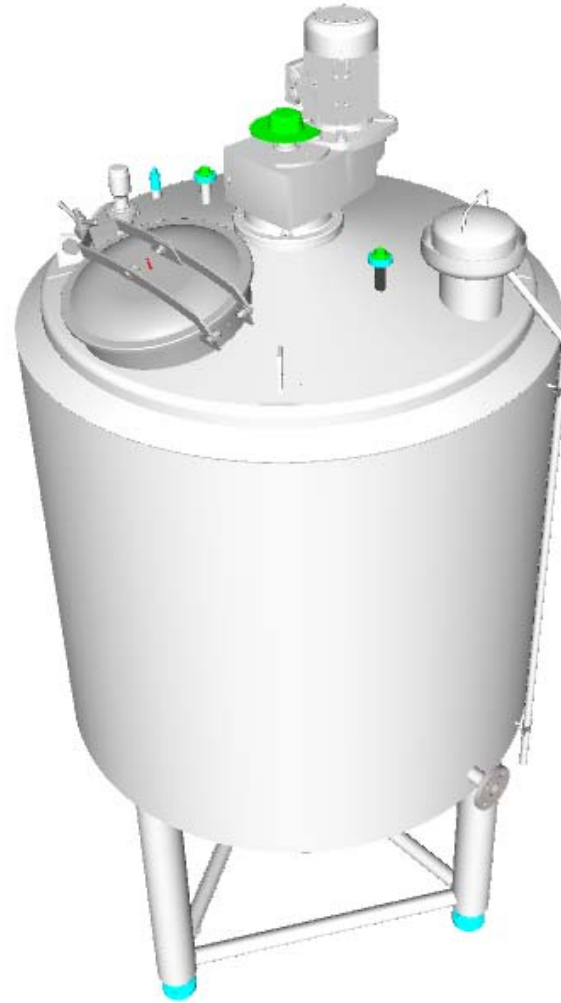
When is detail
necessary?

A complex or
confusing
construction node

A structural node
that moves (e.g.
hinges)

Details of nozzles
and inlets

Weld details



Basics of technical drawing

View
Section (A-A)
Detail

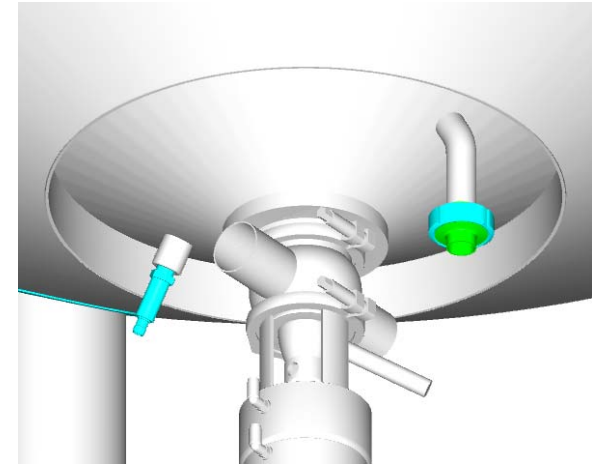
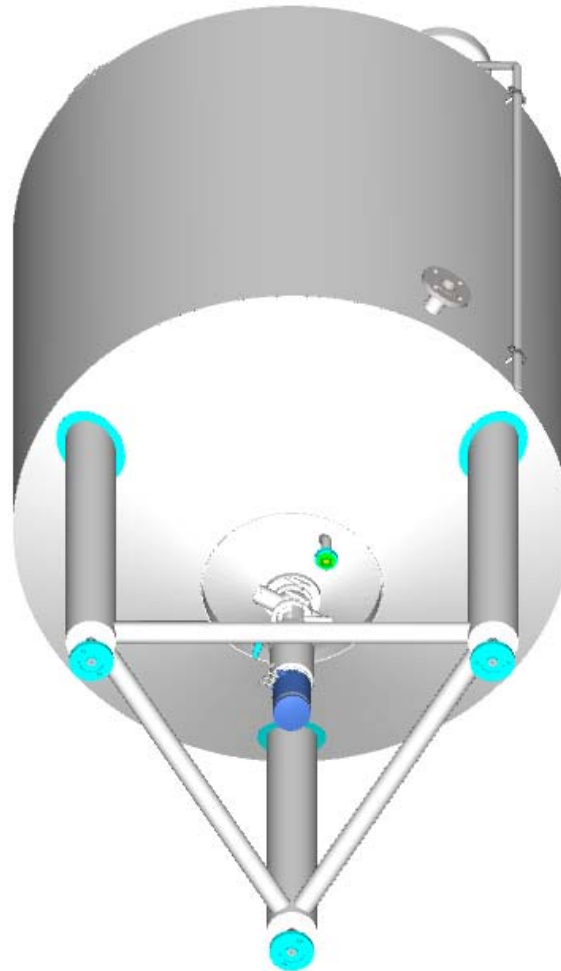
When is detail necessary?

A complex or confusing construction node

A structural node that moves (e.g. hinges)

Details of nozzles and inlets

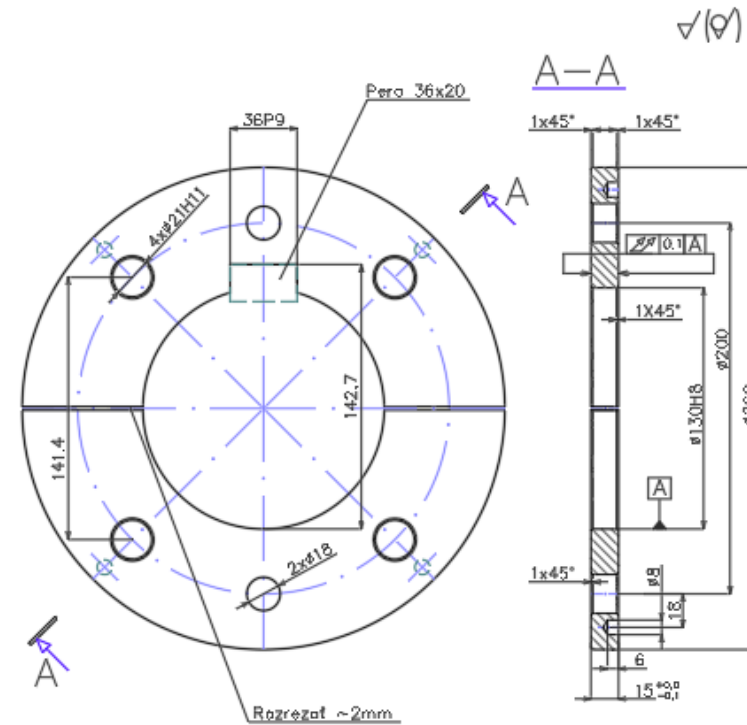
Weld details



Basics of technical drawing

B, Additive information to ensure manufacturability and functionality.

- Dimensioning
- Accuracy of dimensions
- Shape and position tolerances
- Machining quality – roughness
- Other information



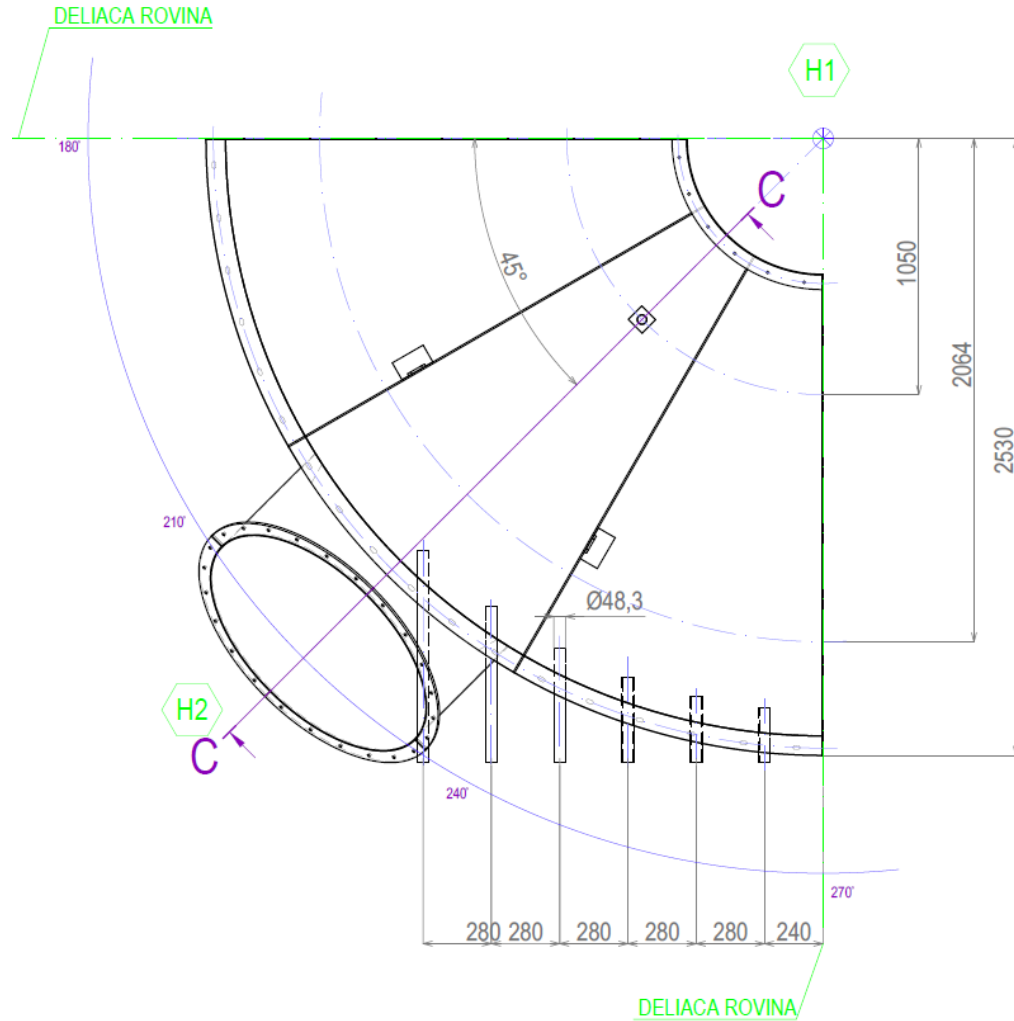
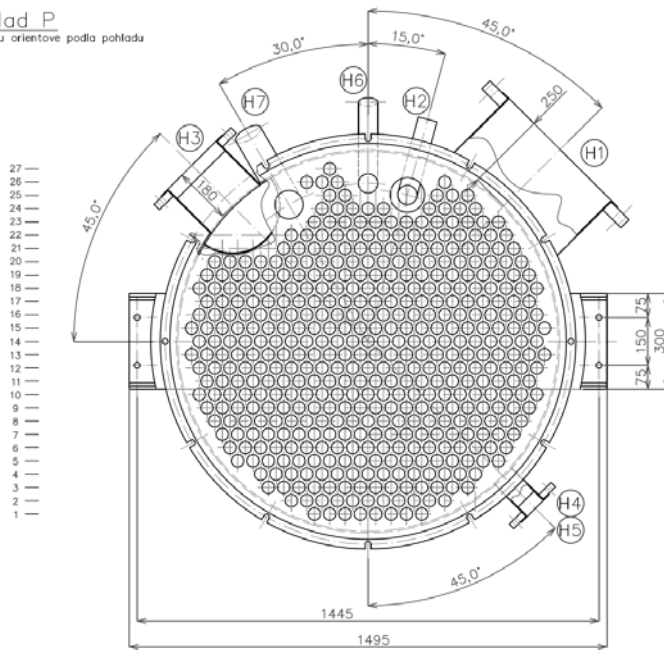
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Poz. Poz.	Výrobné číslo / číslo / Drawing number / číslo /	Název / Polčas Manufactured product	Materiál Material	Norma/Výrobca Standard/Manufacturer	Pod. Item	Číslo No.	Prílohy Attachments
1:2 (1:1)	1:2 (1:1)	Martin Juriga Ivan Madar Ivan Madar		BLOWDEC		1_k.s.	
X10 24484 (1:1)	Blowdec 250 kW						
Ročník Year	RCH Trade s.r.o.						
Forma Form	A4						
Název Name	Koncový delený krúžok						
Číslo No.							
Číslo výkresu Drawing number	BD10-R-24						
Číslo No.							

Basics of technical drawing

Dimensioning

- Accuracy of dimensions
- Shape and position tolerances
- Roughness
- Other information

Pohľad P
Hrdla sú orientované podľa pohľadu



Basics of technical drawing

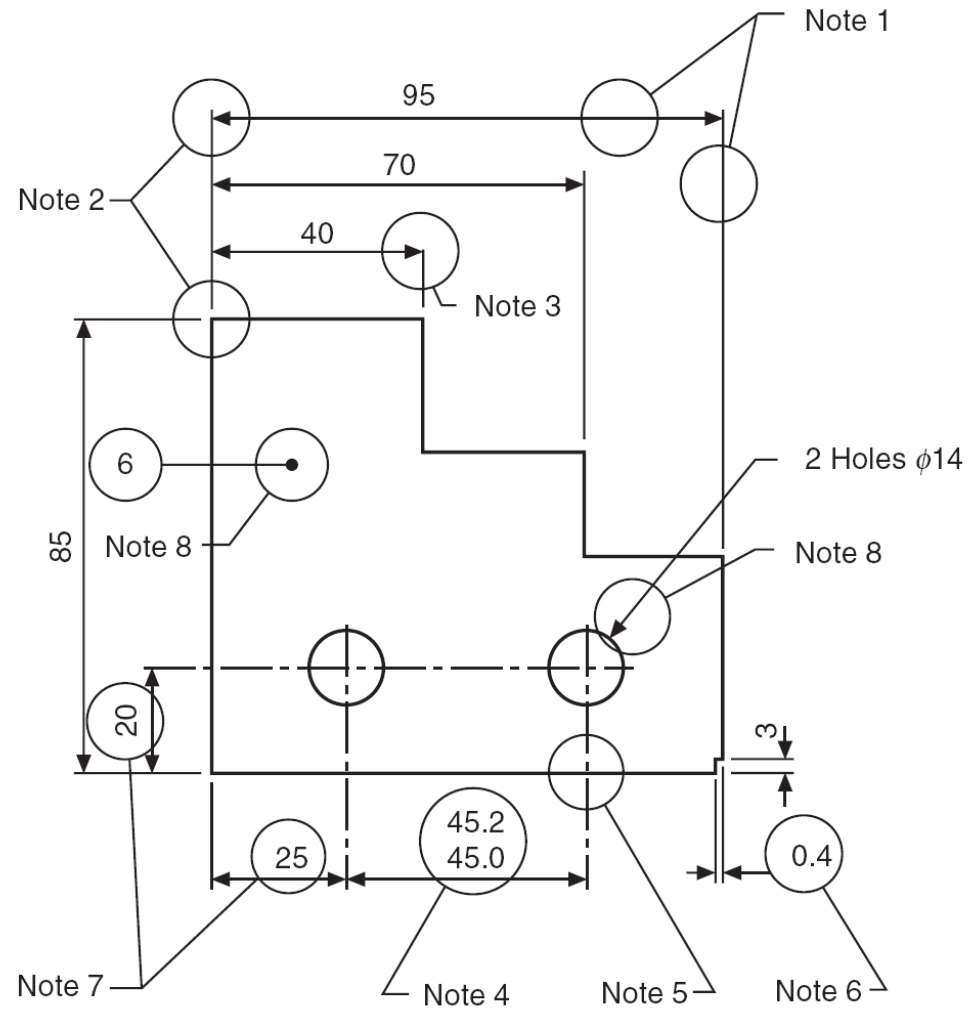
Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

Other information



Basics of technical drawing

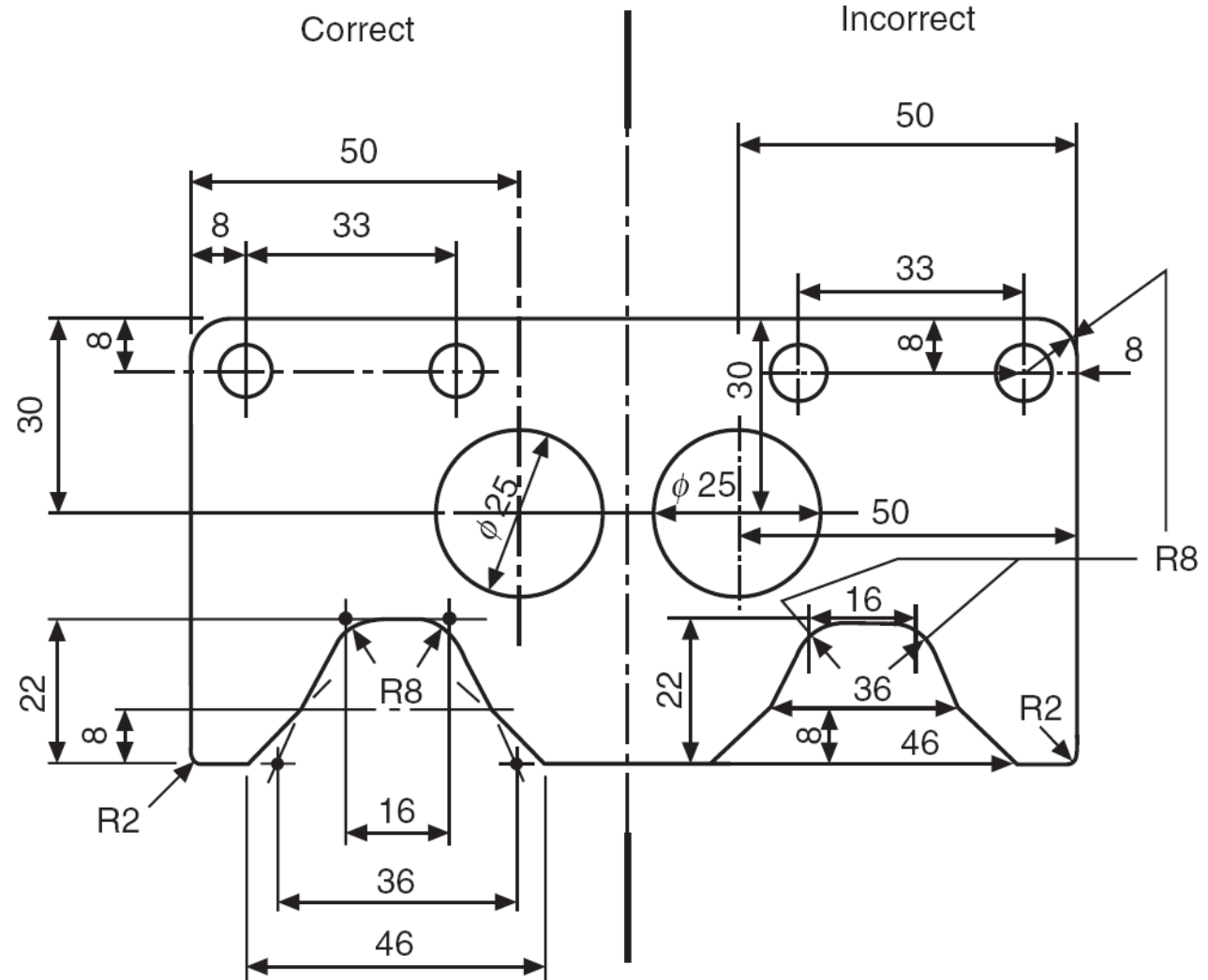
Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

Other information



Basics of technical drawing

Dimensioning

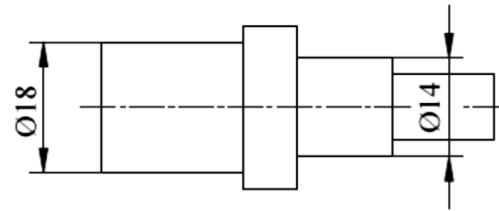
Accuracy of dimensions

Shape and position

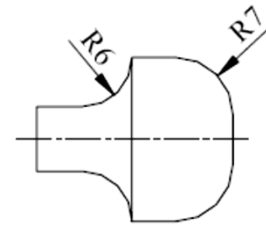
tolerances

Roughness

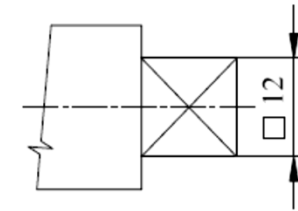
Other information



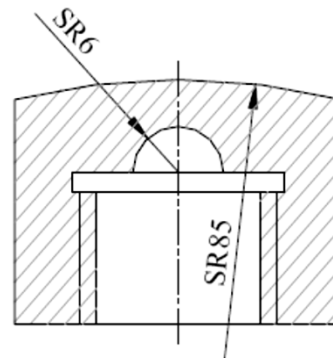
A



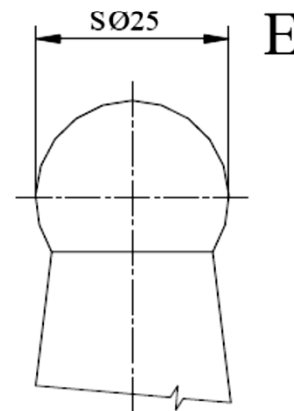
B



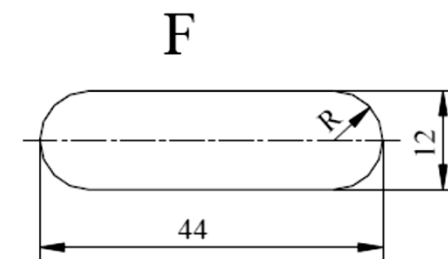
C



D



E

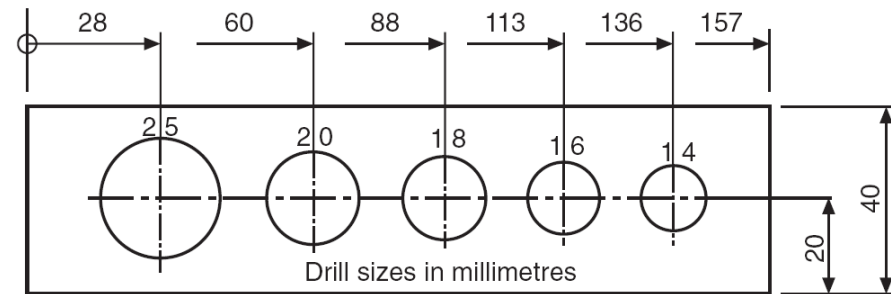
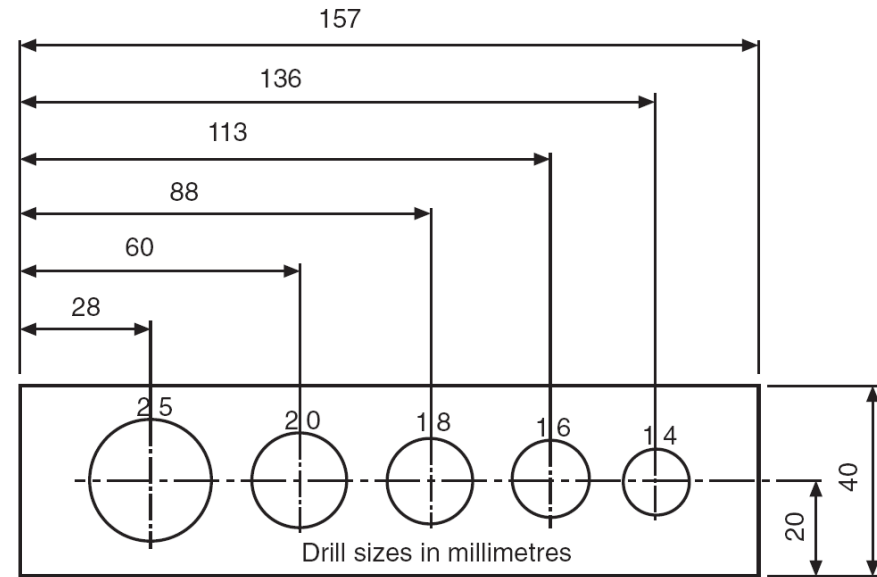
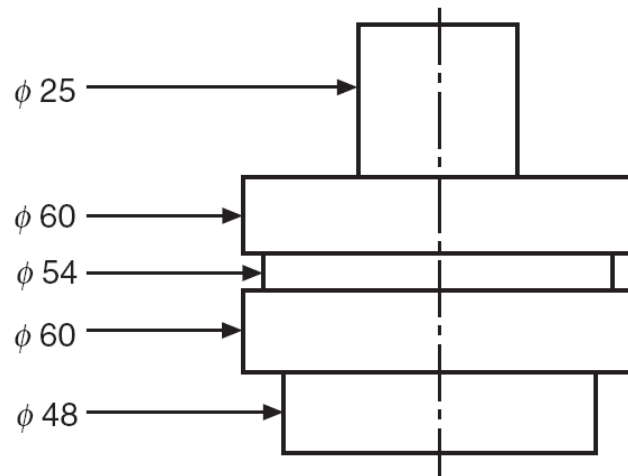


F

Basics of technical drawing

Dimensioning

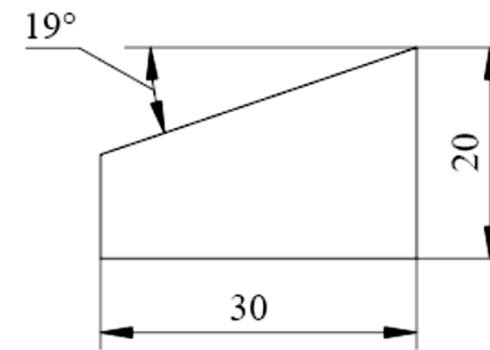
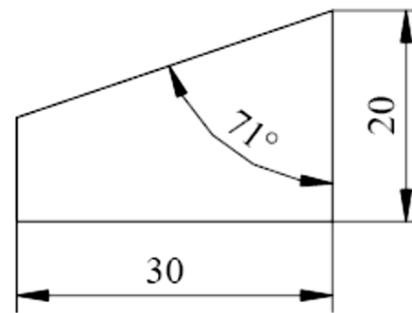
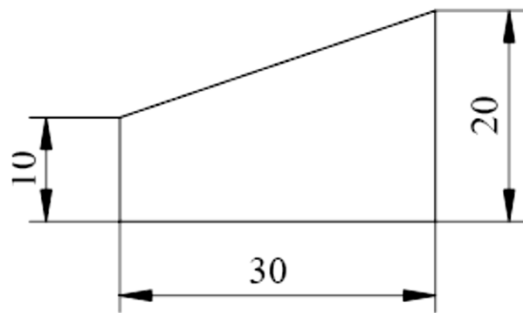
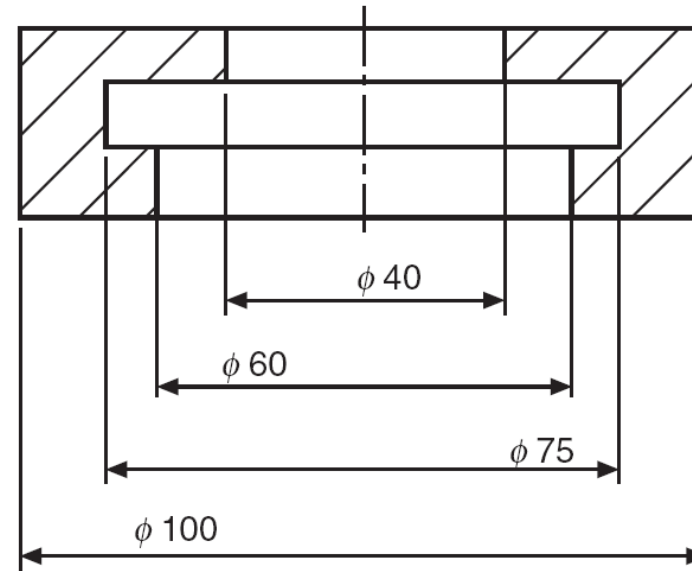
- Accuracy of dimensions
- Shape and position tolerances
- Roughness
- Other information



Basics of technical drawing

Dimensioning

- Accuracy of dimensions
- Shape and position tolerances
- Roughness
- Other information



Basics of technical drawing

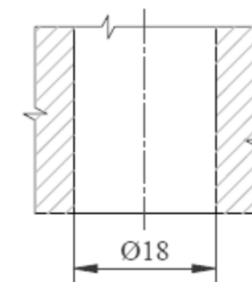
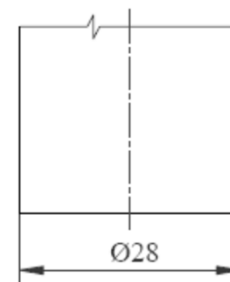
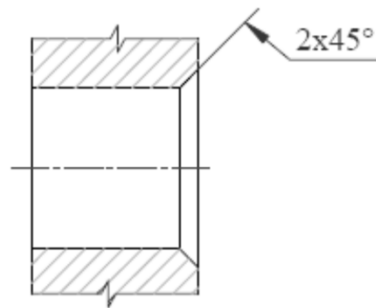
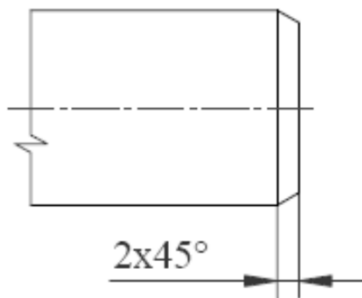
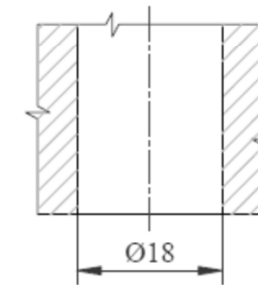
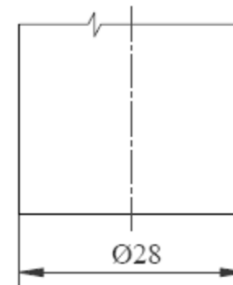
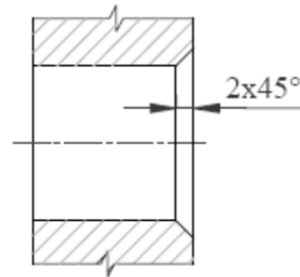
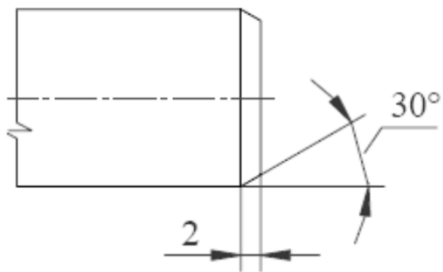
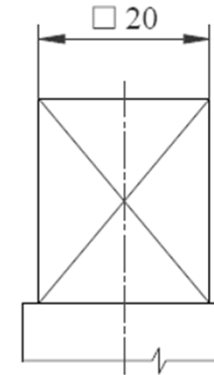
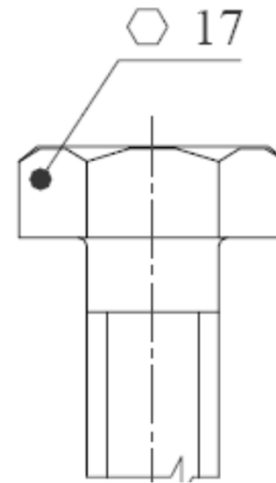
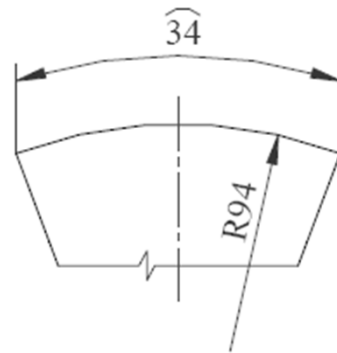
Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

Other information



Basics of technical drawing

Dimensioning

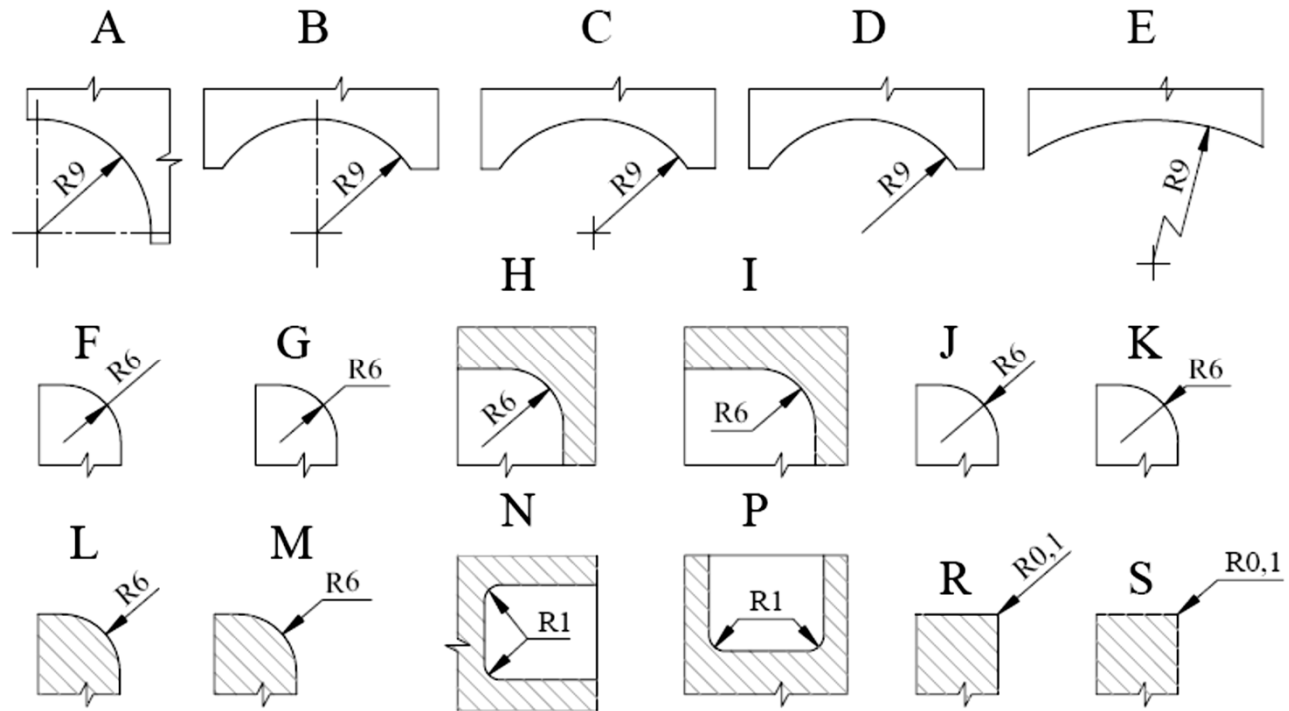
Accuracy of dimensions

Shape and position

tolerances

Roughness

Other information

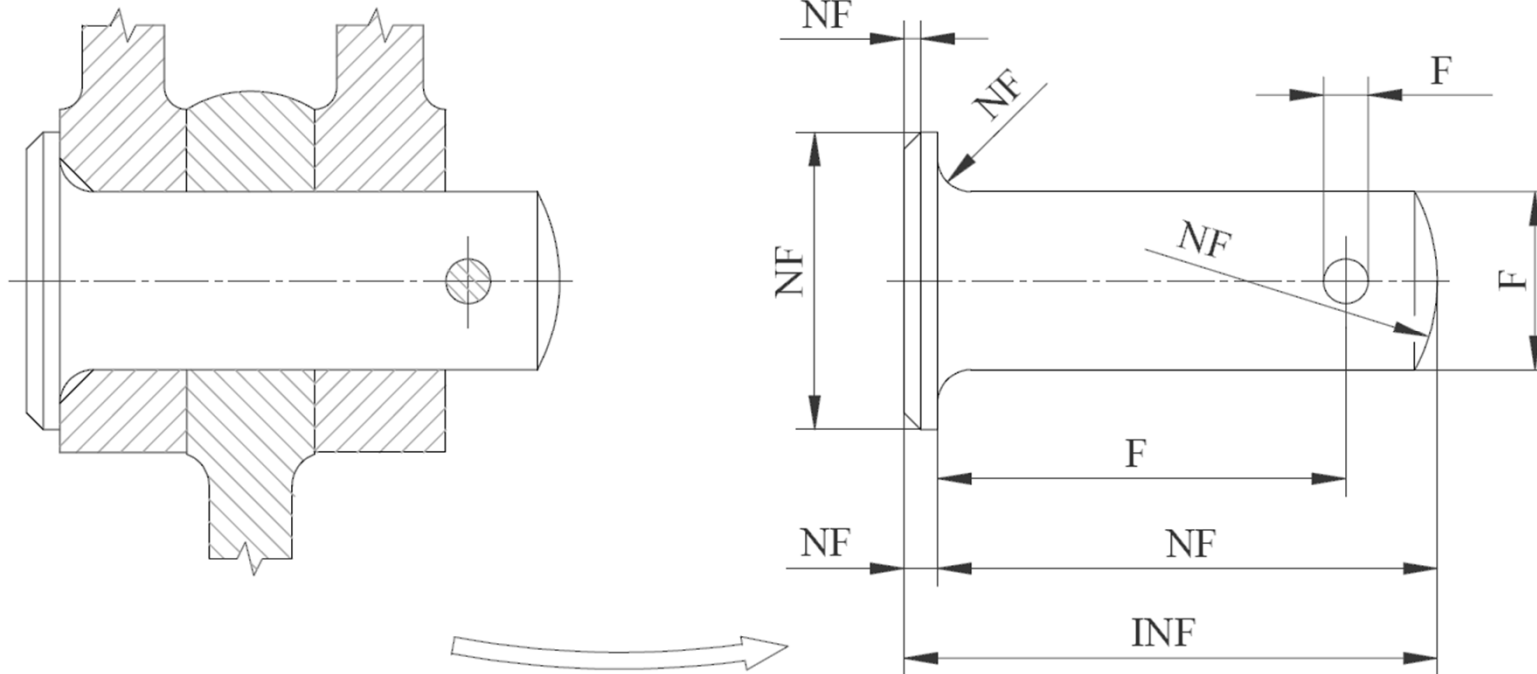


Basics of technical drawing

Dimensioning

- Accuracy of dimensions
- Shape and position tolerances
- tolerances
- Roughness
- Other information

F – functional
NF – non-functional
INF - informative



Basics of technical drawing

Dimensioning

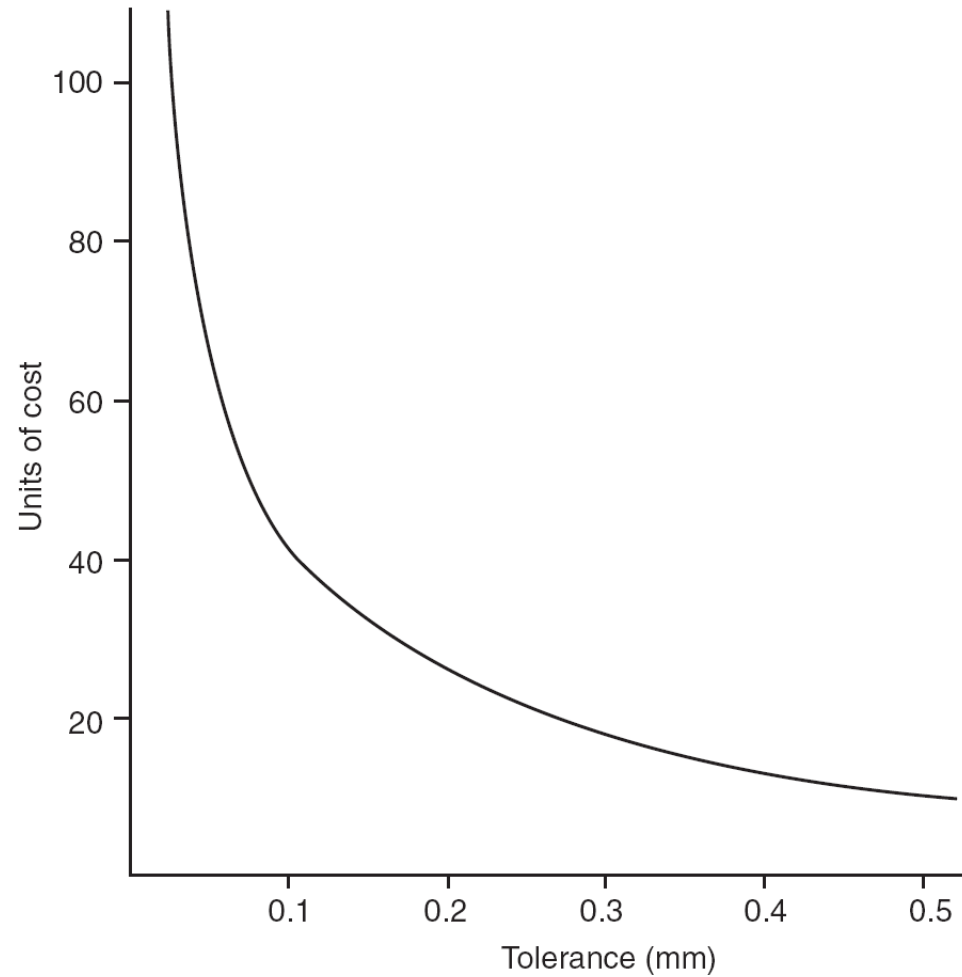
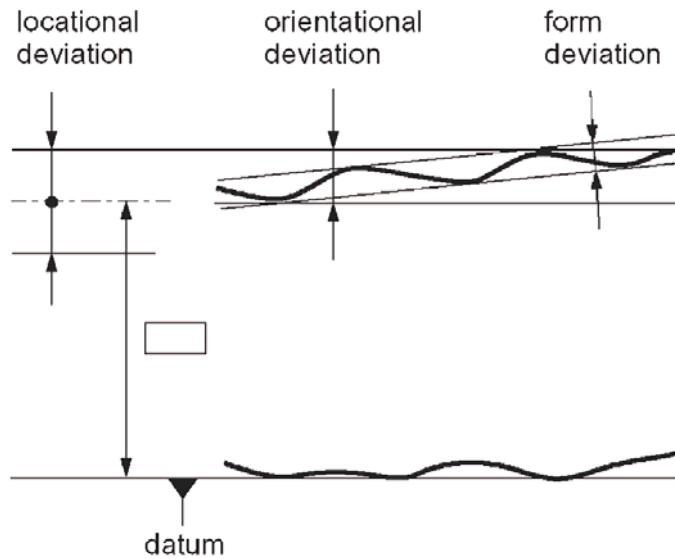
Accuracy of dimensions

Shape and position

tolerances

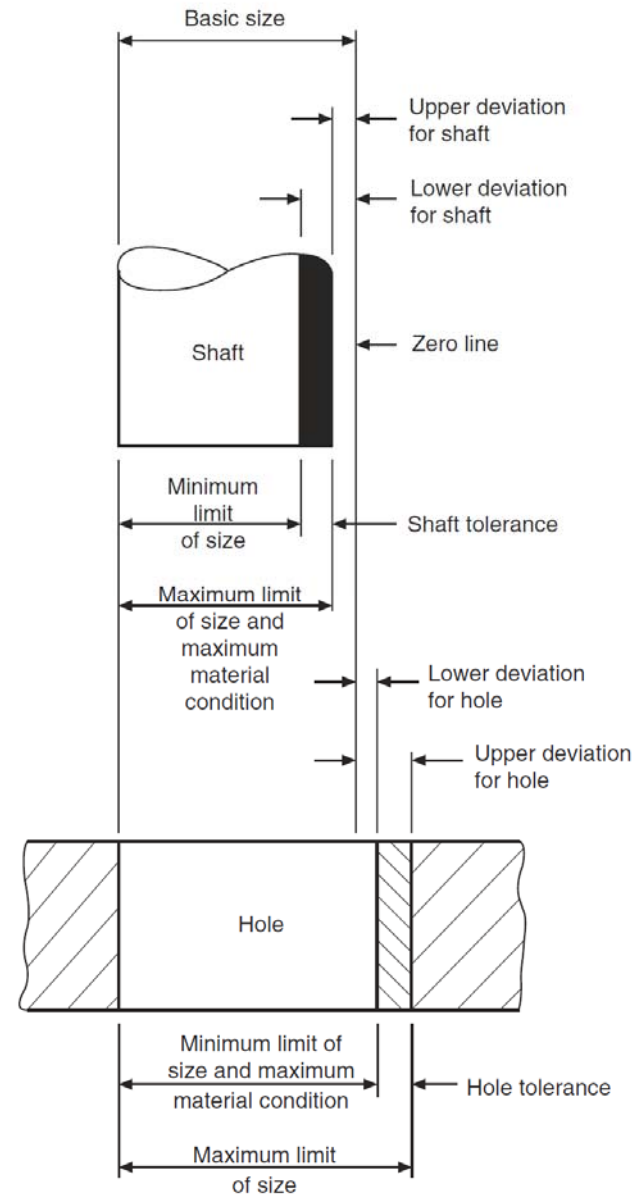
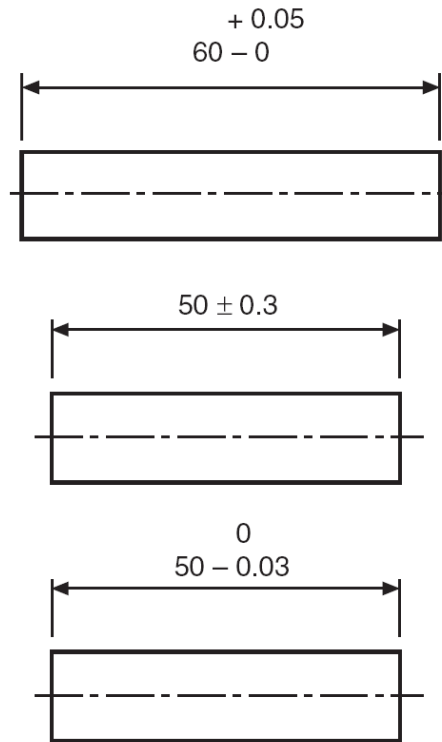
Roughness

Other information



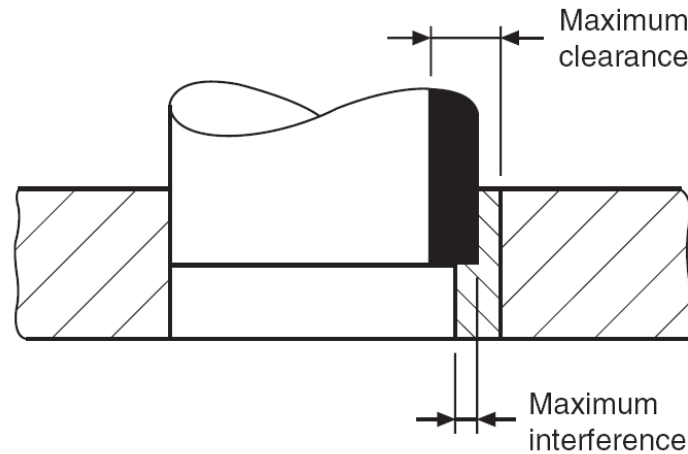
Basics of technical drawing

- Dimensioning
- Accuracy of dimensions
- Shape and position tolerances
- Roughness
- Other information

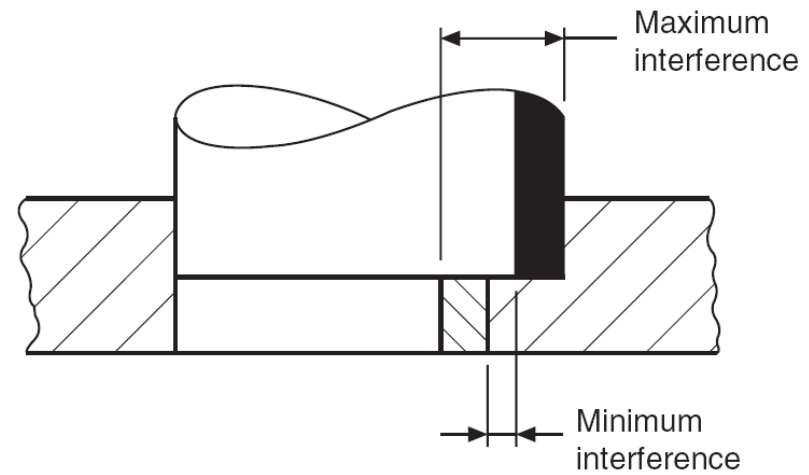
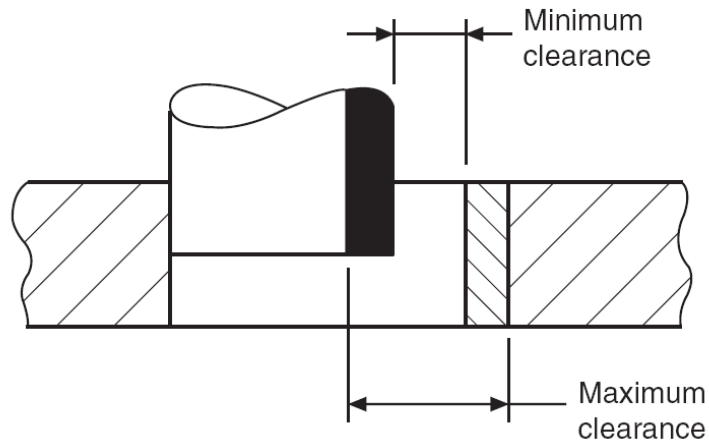


Basics of technical drawing

- Dimensioning
- Accuracy of dimensions**
- Shape and position tolerances
- Roughness
- Other information



A, CLEARANCE
 B, TRANSITION
 C, INTERFERENCE



Basics of technical drawing

Dimensioning

Accuracy of dimensions

Shape and position

tolerances

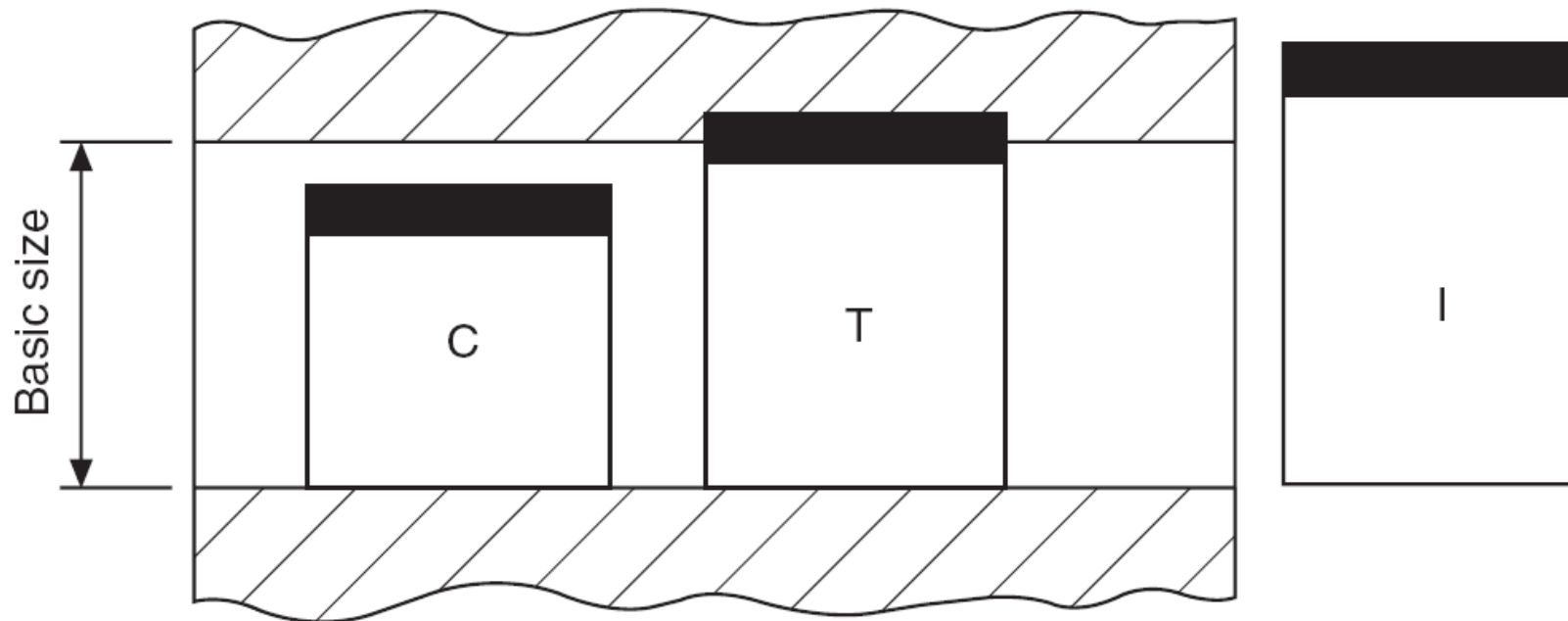
Roughness

Other information

A, CLEARANCE

B, TRANSITION

C, INTERFERENCE



Basics of technical drawing

Dimensioning

Accuracy of dimensions

Shape and position tolerances

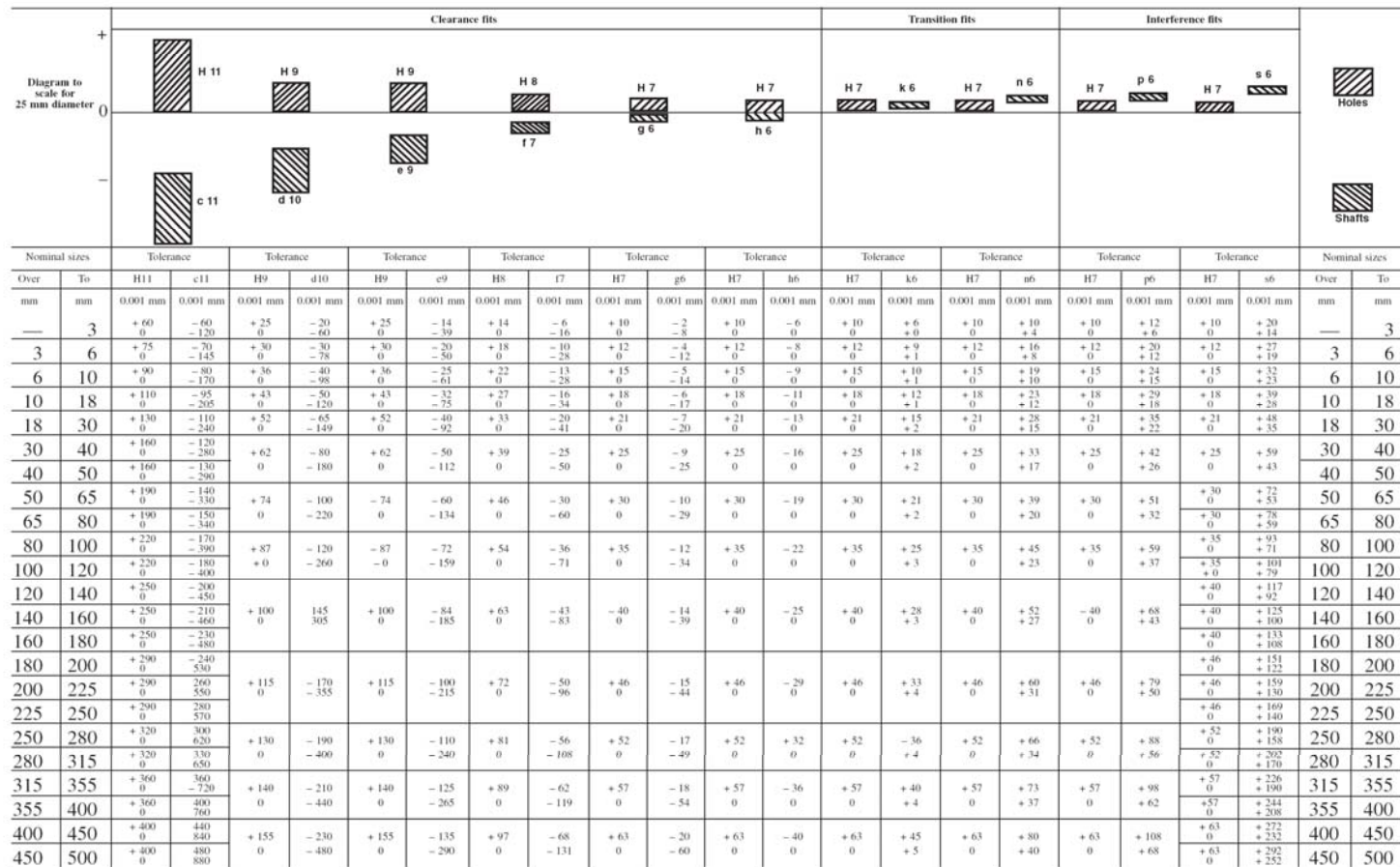
Roughness

Other information

Extracted from BS 4500 : 1969

BRITISH STANDARD SELECTED ISO FITS—HOLE BASIS

Data Sheet 4500A
 Issue 1, February 1970
 confirmed August 1985



Basics of technical drawing

Dimensioning

Accuracy of dimensions

Shape and position tolerances

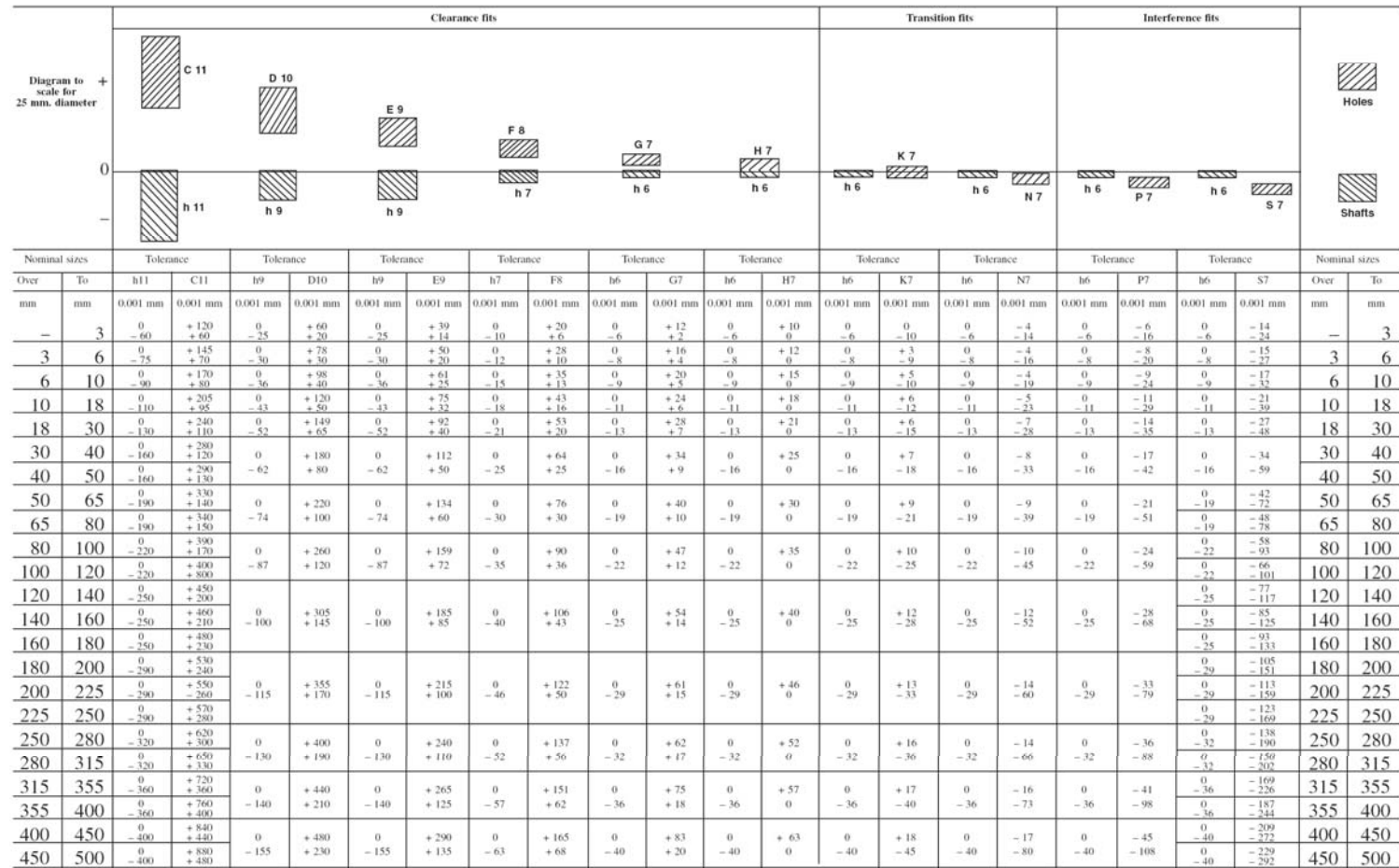
Roughness

Other information

Extracted from BS 4500 : 1969

BRITISH STANDARD SELECTED ISO FITS—SHAFT BASIS

Data Sheet 4500B
 Issue 1, February 1970



Basics of technical drawing

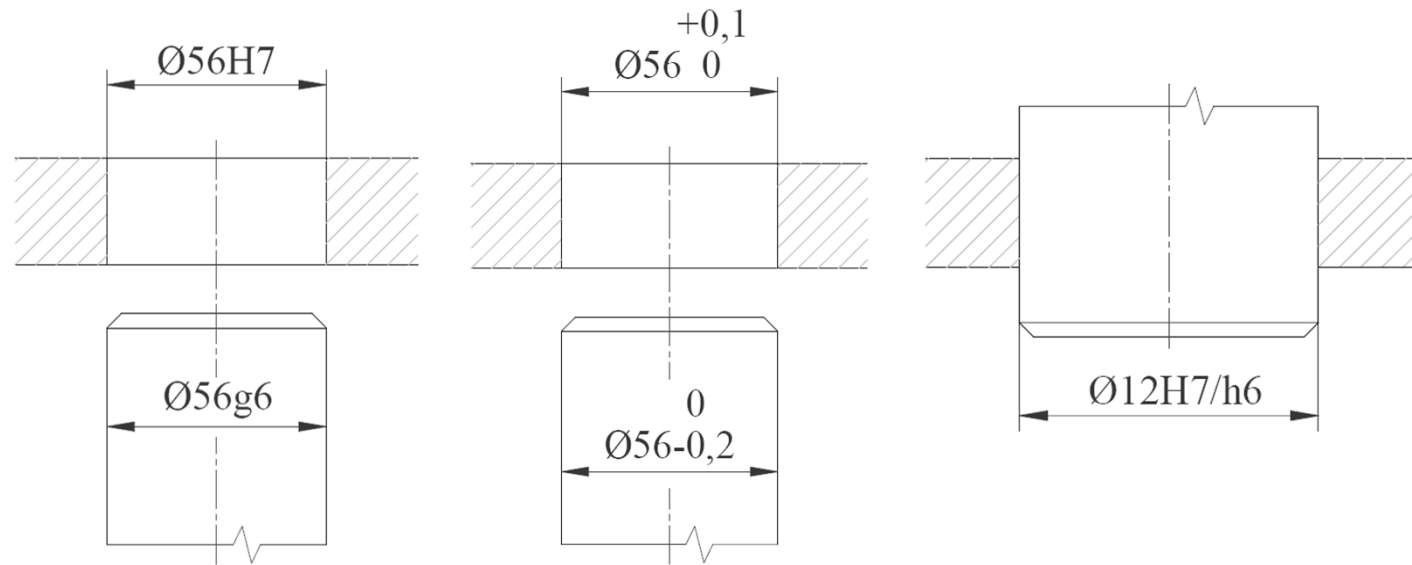
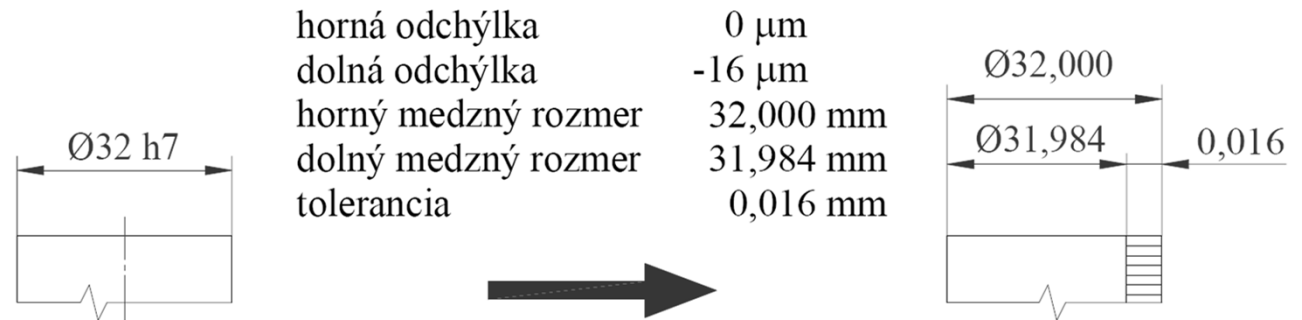
Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

Other informatio



Basics of technical drawing

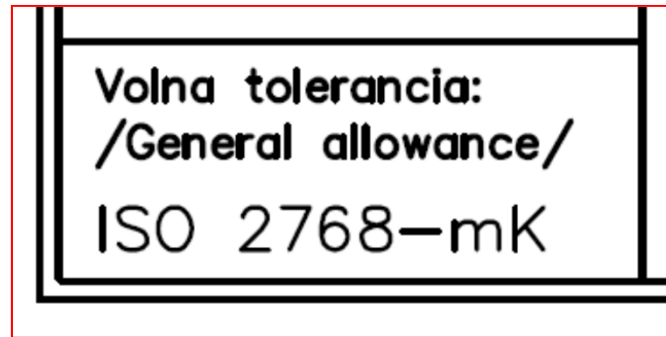
Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

Other information



ISO 13920:2023 Welding - General tolerances for welded constructions - Dimensions for lengths and angles - Shape and position.

ISO 2768-1:1989 General tolerances,. Part 1: Tolerances for linear and angular dimensions without individual tolerance indications

Tolerance class		Permissible deviations for basic size range							
Designation	Description	from 0,5* up to 3	over 3 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 400	over 400 up to 1000	over 1000 up to 2000	over 2000 up to 4000
f	fine	± 0,05	± 0,05	± 0,1	± 0,15	± 0,2	± 0,3	± 0,5	--
m	medium	± 0,1	± 0,1	± 0,2	± 0,3	± 0,5	± 0,8	± 1,2	± 2
c	coarse	± 0,2	± 0,3	± 0,5	± 0,8	± 1,2	± 2	± 3	± 4
v	very coarse	--	± 0,5	± 1	± 1,5	± 2,5	± 4	± 6	± 8

* For nominal size below 0,5 mm, the deviation shall be indicated adjacent to the relevant nominal size(s).

Basics of technical drawing

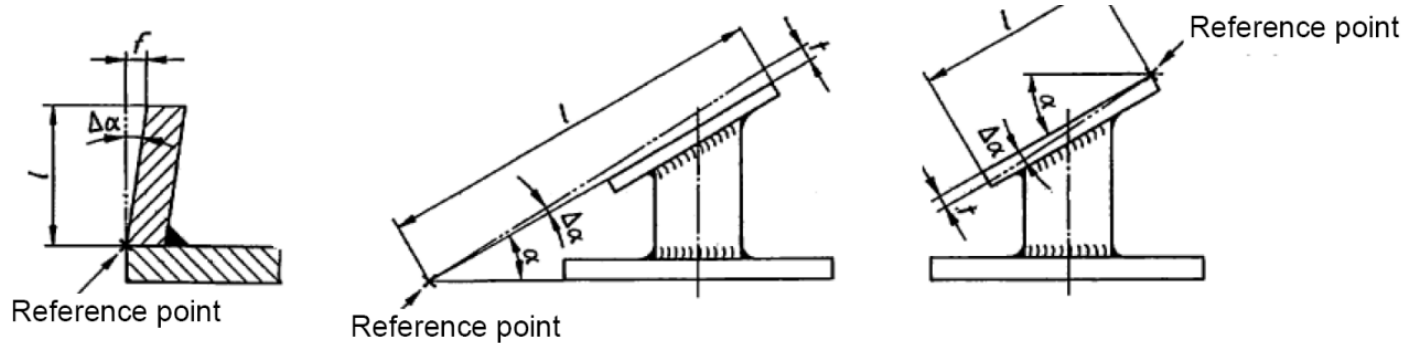
Dimensioning

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1. Tolerances for length dimensions

Length ranges	up to 400	over 400 - 1000	over 1000 - 2000	over 2000 - 4000
Tolerances	± 1.0	± 2.0	± 3.0	± 4.0

2. Tolerances for angle dimensions

Length ranges of the shorter leg	up to 10	over 10 - 50	over 50 - 120	over 120 - 400	starting at 400
Tolerances $\Delta\alpha$ (in degree and min.)	± 1°	± 0°30'	± 0°20'	± 0°10'	± 0°5'
Tolerances t (in mm/m)	± 0.2	± 0.4	± 0.7	± 1.1	± 1.1

Basics of technical drawing

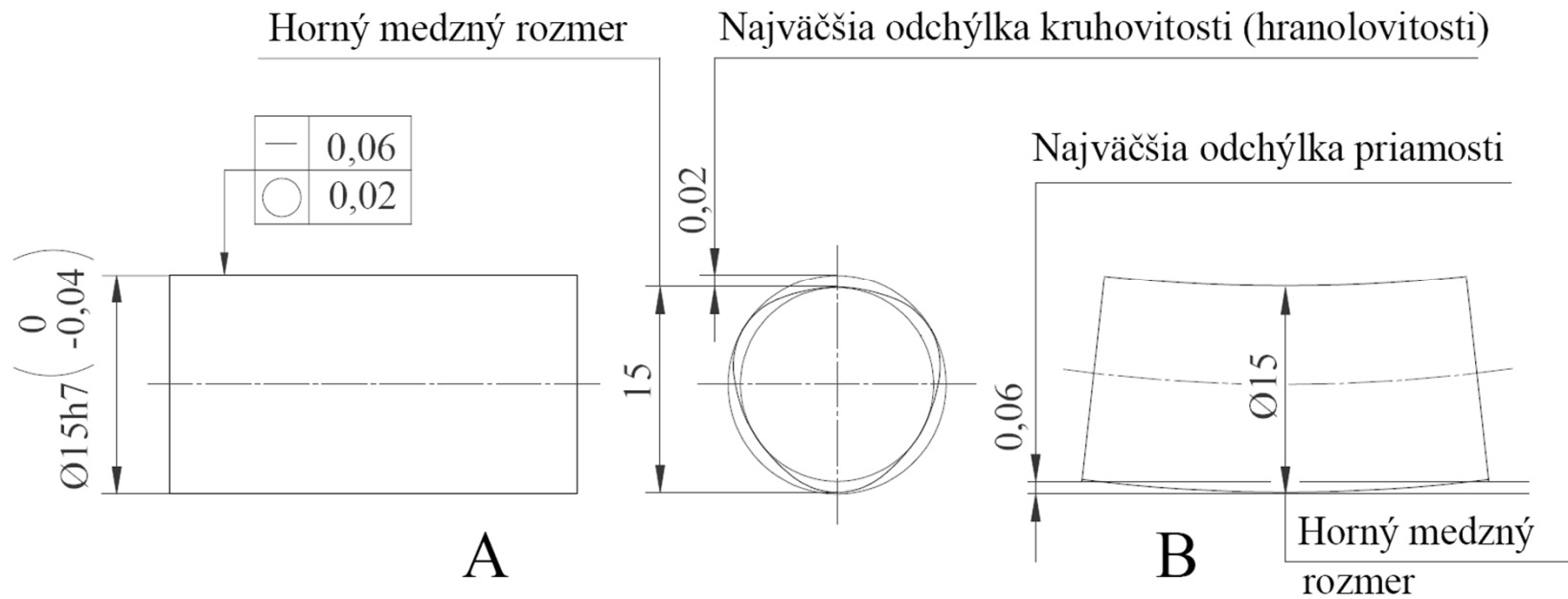
Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

Other information



Basics of technical drawing

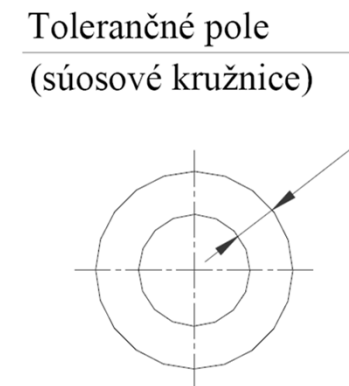
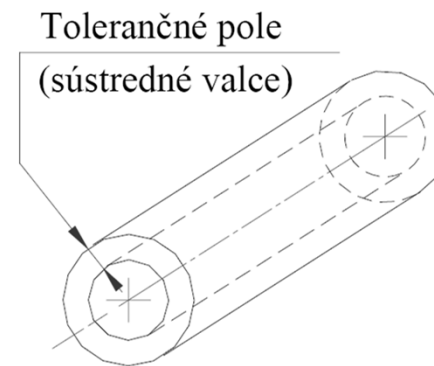
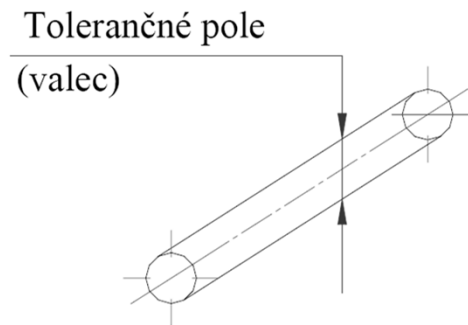
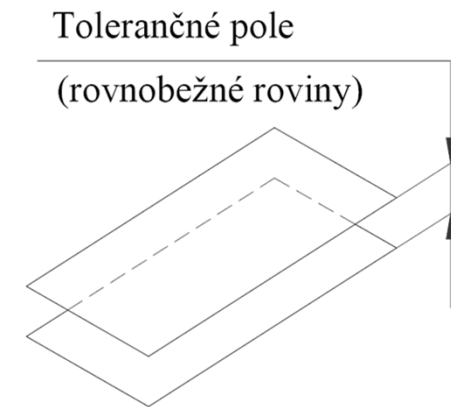
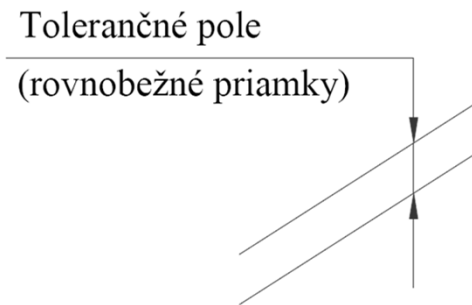
Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

Other information



Basics of technical drawing

Dimensioning







Accuracy of dimensions

Shape and position tolerances

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Other information

Symbols for geometrical characteristics

Type of tolerance	Characteristics to be tolerated	Symbol	Datum needed	Applications
Form	Straightness	—	No	A straight line. The edge or axis of a feature.
	Flatness		No	A plane surface.
	Roundness		No	The periphery of a circle. Cross-section of a bore, cylinder, cone or sphere.
	Cylindricity		No	The combination of circularity, straightness and parallelism of cylindrical surfaces. Mating bores and plungers.
	Profile of a line		No	The profile of a straight or irregular line.
	Profile of a surface		No	The profile of a straight or irregular surface.
	Parallelism	//	Yes	Parallelism of a feature related to a datum. Can control flatness when related to a datum.
	Perpendicularity		Yes	Surfaces, axes, or lines positioned at right angles to each other.

Basics of technical drawing

Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

Other information

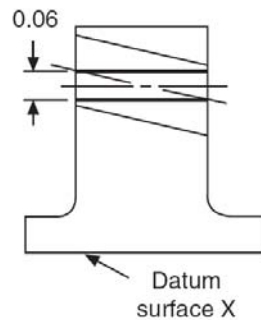
Orientation	Angularity		Yes	The angular displacement of surfaces, axes, or lines from a datum.
	Profile of a line		Yes	The profile of a straight or irregular line positioned by theoretical exact dimensions with respect to datum plane(s).
	Profile of a surface		Yes	The profile of a straight or irregular surface positioned by theoretical exact dimensions with respect to datum plane(s).
Location	Position		See note below	The deviation of a feature from a true position.
	Concentricity and coaxiality		Yes	The relationship between two circles having a common centre or two cylinders having a common axis.
	Symmetry		Yes	The symmetrical position of a feature related to a datum.
	Profile of a line		Yes	The profile of a straight or irregular line positioned by theoretical exact dimensions with respect to datum plane(s).
	Profile of a surface		Yes	The profile of a straight or irregular surface positioned by theoretical exact dimensions with respect to datum plane(s).
Runout	Circular runout		Yes	The position of a point fixed on a surface of a part which is rotated 360° about its datum axis.
	Total runout		Yes	The relative position of a point when traversed along a surface rotating about its datum axis.

Basics of technical drawing

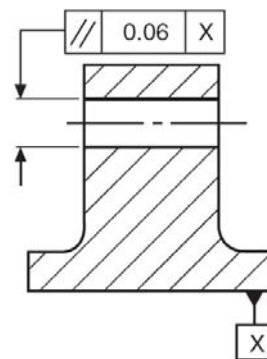
- Dimensioning
- Accuracy of dimensions
- Shape and position tolerances
- Roughness
- Other information

- Angularity
- Parallelism
- Perpendicularity

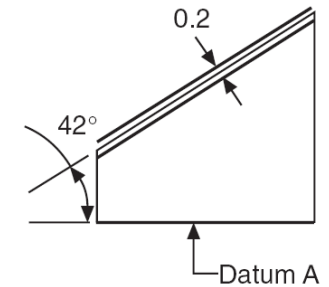
Product requirement
 The axis of the hole must be contained between two planes 0.06 apart parallel to the datum surface X.



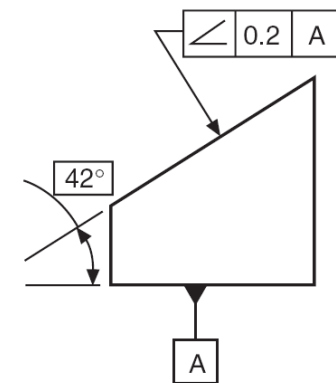
Drawing instruction



Product requirement
 The inclined surface must be contained within two parallel planes 0.2 apart which are at an angle of 42° to the datum surface.



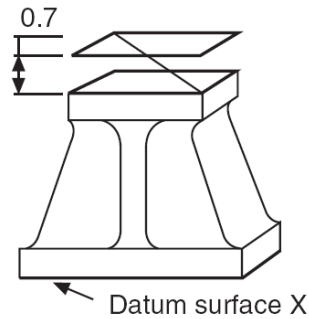
Drawing instruction



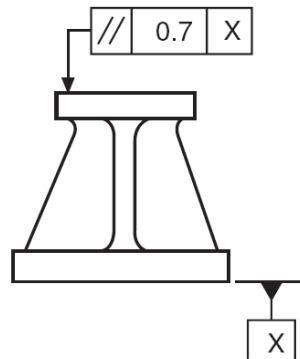
Basics of technical drawing

- Dimensioning
- Accuracy of dimensions
- Shape and position tolerances
- Roughness
- Other information

Product requirement
 The top surface of the component must be contained between two planes 0.7 apart and parallel to the datum surface X.

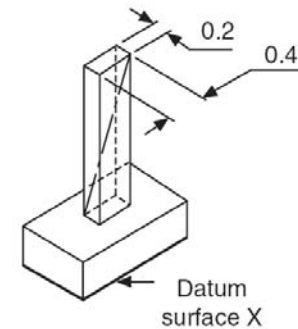


Drawing instruction

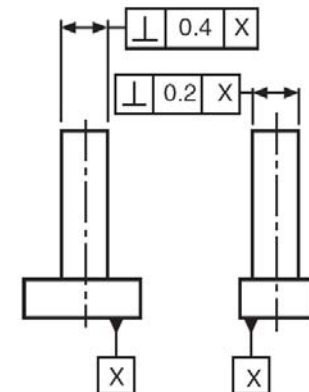


- Angularity
- Parallelism
- Perpendicularity

Product requirement
 The axis of the column must be contained in a tolerance-zone box 0.2×0.4 which is perpendicular to the datum surface X.



Drawing instruction

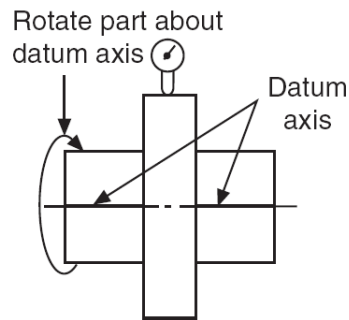


Basics of technical drawing

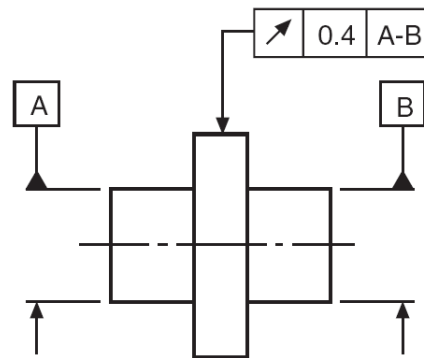
- Dimensioning
- Accuracy of dimensions
- Shape and position tolerances
- Roughness
- Other information

Product requirement

The circular radial run-out must not exceed 0.4 at any point along the cylinder, measured perpendicular to the datum axis without axial movement.



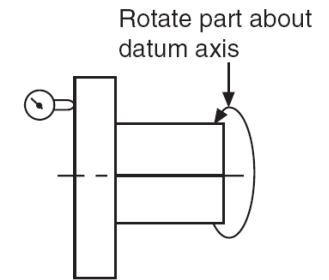
Drawing instruction



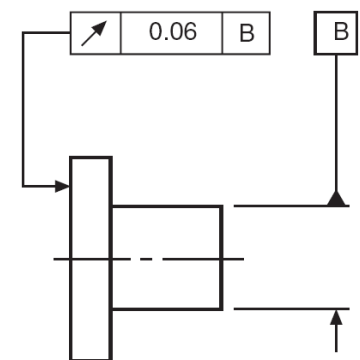
Circular runout

Product requirement

At any radius, the circular run-out must not exceed 0.06 measured parallel to the datum axis.



Drawing instruction



Basics of technical drawing

Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

Other information

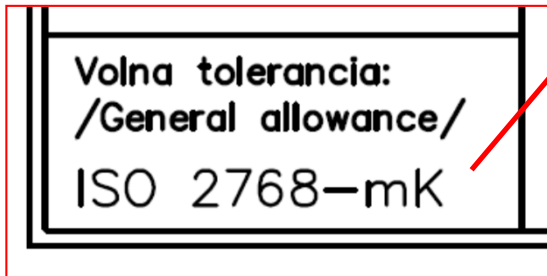


Table 1 — General tolerances on straightness and flatness

Values in millimetres

Tolerance class	Straightness and flatness tolerances for ranges of nominal lengths					
	up to 10	over 10 up to 30	over 30 up to 100	over 100 up to 300	over 300 up to 1 000	over 1 000 up to 3 000
H	0,02	0,05	0,1	0,2	0,3	0,4
K	0,05	0,1	0,2	0,4	0,6	0,8
L	0,1	0,2	0,4	0,8	1,2	1,6

Table 2 — General tolerances on perpendicularity

Values in millimetres

Tolerance class	Perpendicularity tolerances for ranges of nominal lengths of the shorter side			
	up to 100	over 100 up to 300	over 300 up to 1 000	over 1 000 up to 3 000
H	0,2	0,3	0,4	0,5
K	0,4	0,6	0,8	1
L	0,6	1	1,5	2

Basics of technical drawing

Dimensioning

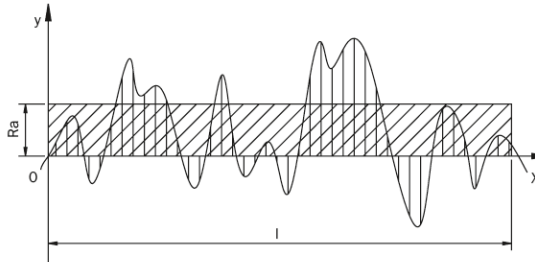
Accuracy of dimensions

Shape and position tolerances

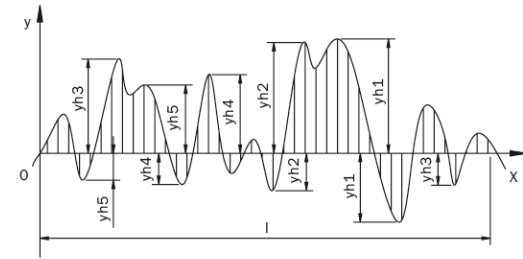
Roughness

Other information

Arithmetical mean roughness value R_a



Average roughness height (peak-to-valley height) R_z



Definition of Surface Roughness

The following roughness measured values are described in DIN EN ISO 4288. The standard describes how roughness values are determined with electrical surface profiling devices.

The average roughness value R_a (μm)

is the arithmetical mean of the absolute values of profile fluctuation within roughness reference section l .

This means: The sum of individual surfaces which are between the X axis and the actual profile is equal to the surface area of a certain rectangular area. (All individual surfaces are added, regardless of whether they are above or below the middle line). The height of the rectangular area is the R_a value and the width is the length of the reference section. The R_a variable is the preferred variable.

The average roughness height (peak-to-valley height) R_z (μm)

is the arithmetical mean value from the individual roughness depths of five adjacent individual measurement sections (acc. to DIN EN ISO 4287).

The highest and the lowest points on each individual measurement section are used as the basis for calculation.

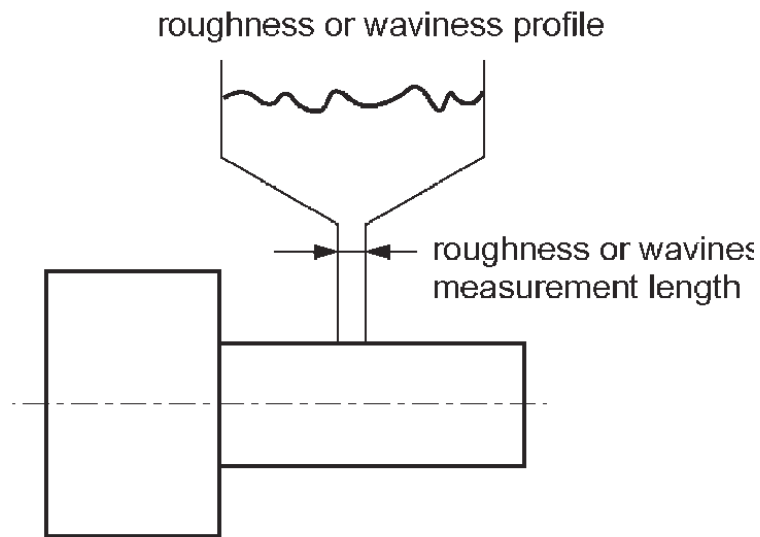
The maximum roughness (peak-to-valley height) R_{max} (μm)

is the greatest of the individual roughness depth over the entire measurement section.

Other roughness depths, such as the mean spacing of profile irregularities R_{Sm} , maximum profile peak height R_p or the maximum profile valley depth R_M are not relevant to the food industry because of the transparency.

Basics of technical drawing

- Dimensioning
- Accuracy of dimensions
- Shape and position tolerances
- Roughness**
- Other information








Geometrical deviation Profile diagram	Description Examples of origin
1st order: Form 	errors in guidance of machine tool, deflections of machine tool or workpiece, error in fixture of workpiece, warping, wear
2nd order: Waviness 	eccentric fixture, form deviation of tool, vibration
3rd order: Roughness 	grooves, form of tool cutting edge, horizontal and vertical feed
4th order: Roughness 	cutting process (tear chip, shear chip), deformation from blasting, germination with galvanizing
5th order: Roughness not presentable	crystallization process, mordant, corrosion
6th order: Roughness not presentable	crystal structure
Superposition 	actual surface

Fig. 1.5 Superposition of surface deviations (DIN 4760)

Basics of technical drawing

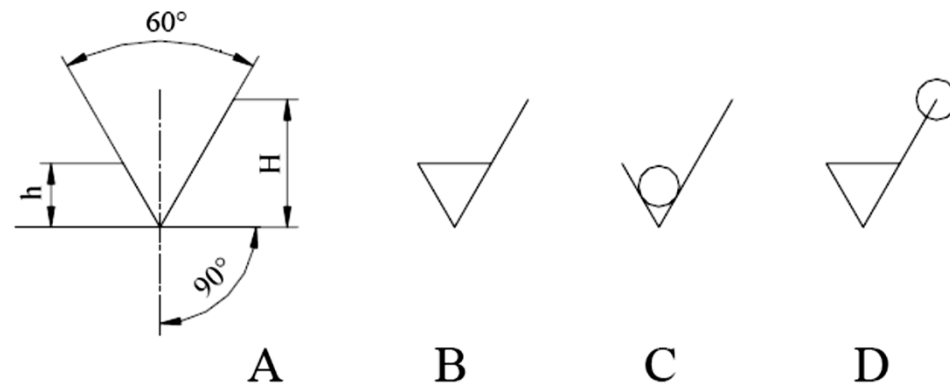
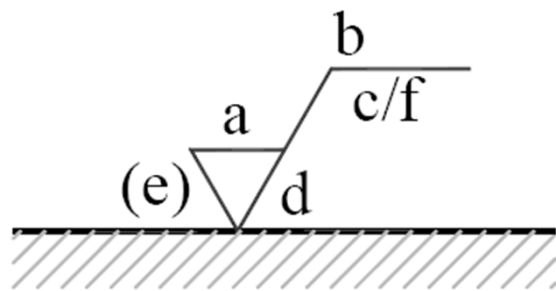
Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

Other information



- a** - značka a číselná hodnota drsnosti R_a v mikrometroch,
- b** - spôsob konečného spracovania, výrobná metóda, opracovanie, úprava povrchu, atď.,
- c** - výška vlnitosti v mikrometroch, pred ktorou je uvedená značka parametra alebo základná dĺžka v milimetroch (pre R_a , R_z , R_y sa táto hodnota vynecháva),
- d** - značka smeru nerovnosti povrchu (C-kruhový, M-rôzny, X-skřížený v dvoch smeroch, =-rovnoobežný s rovinou premietania daného pohľadu kde je značka použitá, atď.),
- e** - prídavok na opracovanie,
- f** - hodnota drsnosti iná ako R_a v mikrometroch, pred ktorou sa uvedie značka parametra, napr. $R_y 0,4$.

Basics of technical drawing

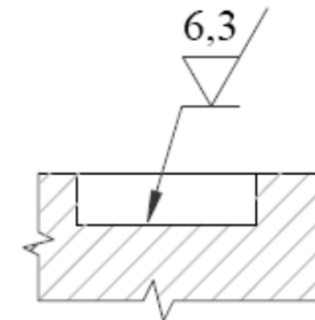
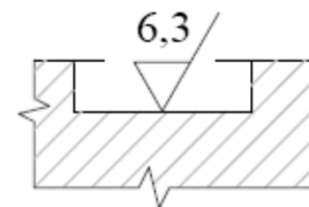
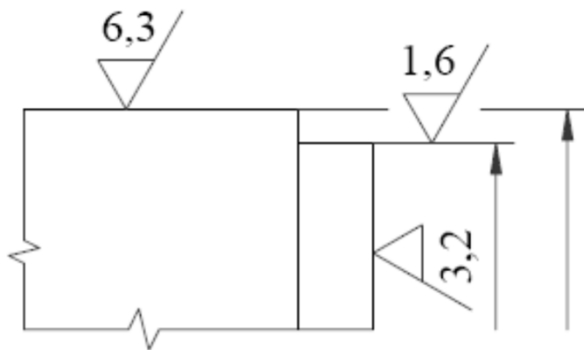
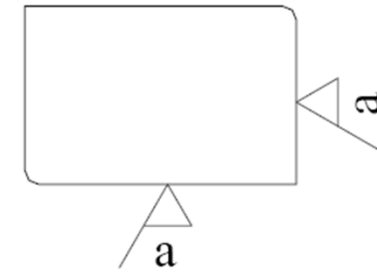
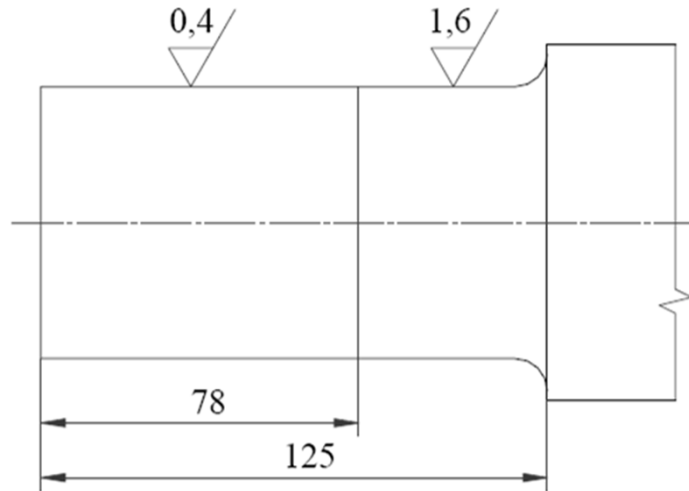
Dimensioning

Accuracy of dimensions

Shape and position tolerance

Roughness

Other information



Basics of technical drawing

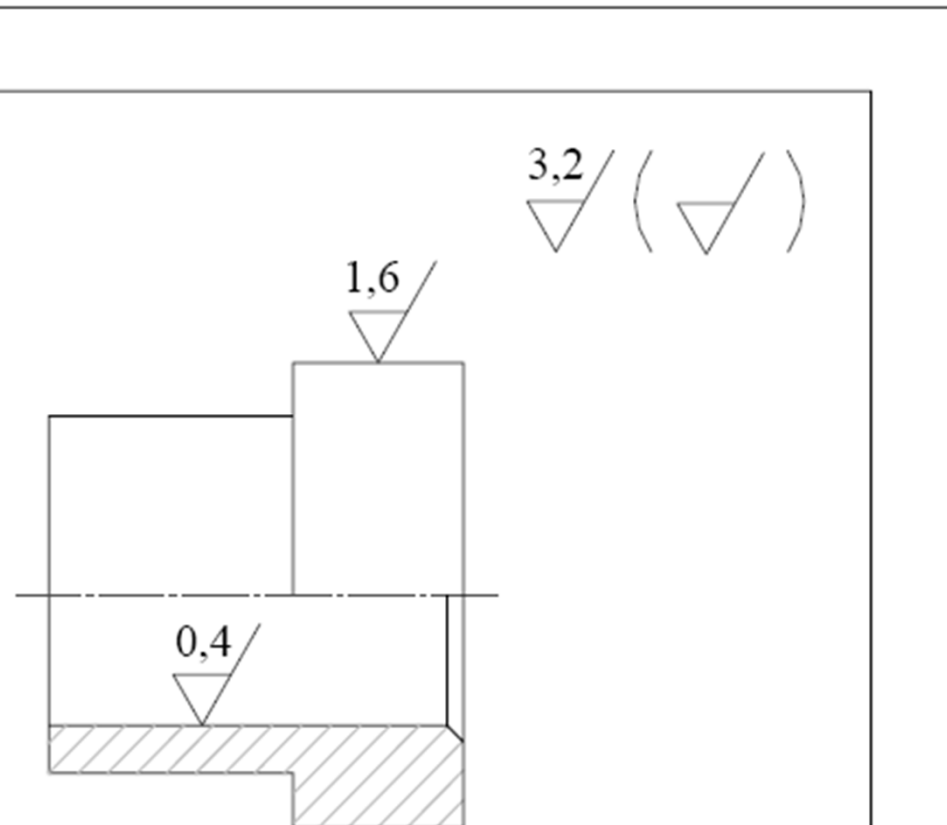
Dimensioning

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Basics of technical drawing

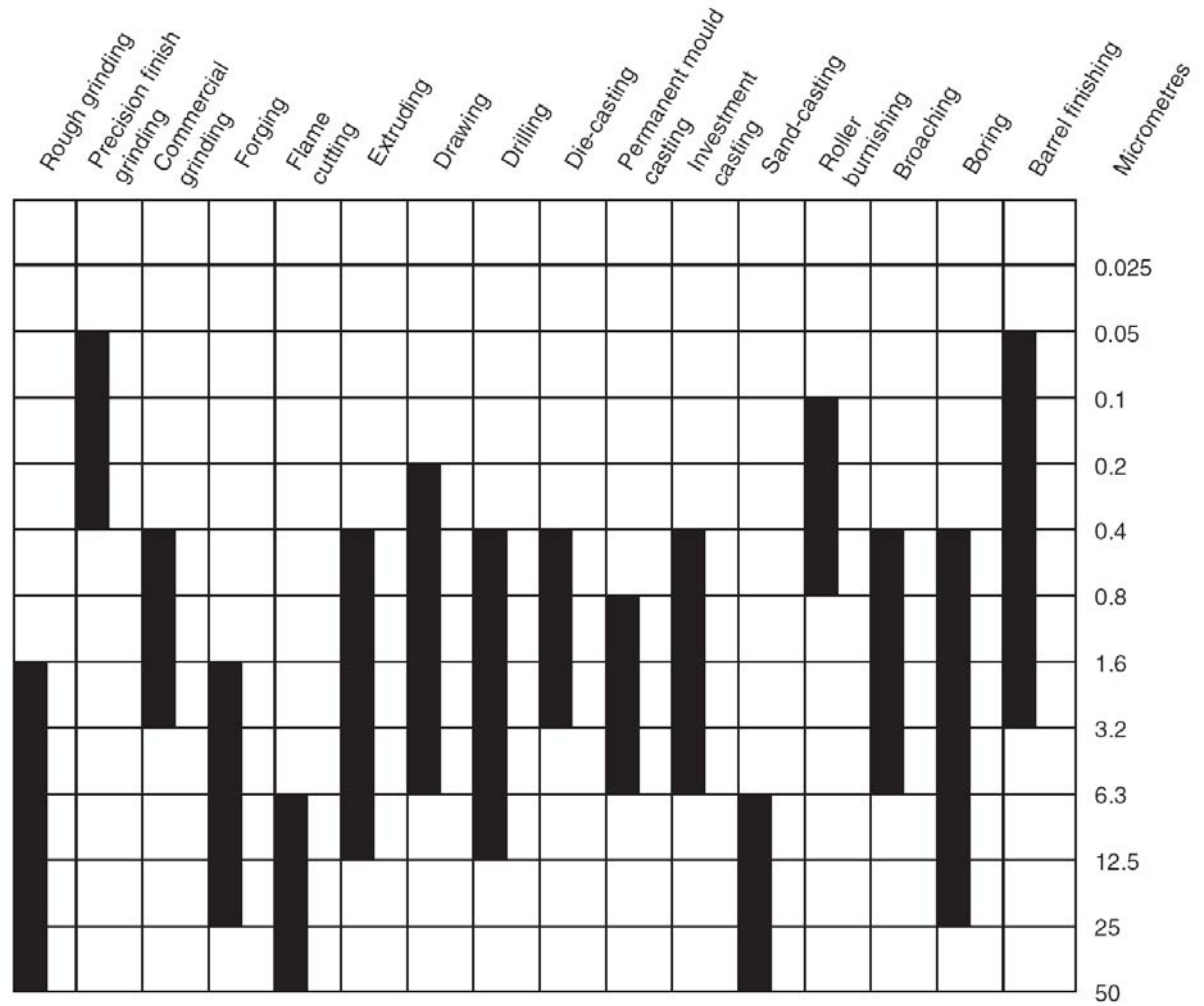
Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

Other information



Basics of technical drawing

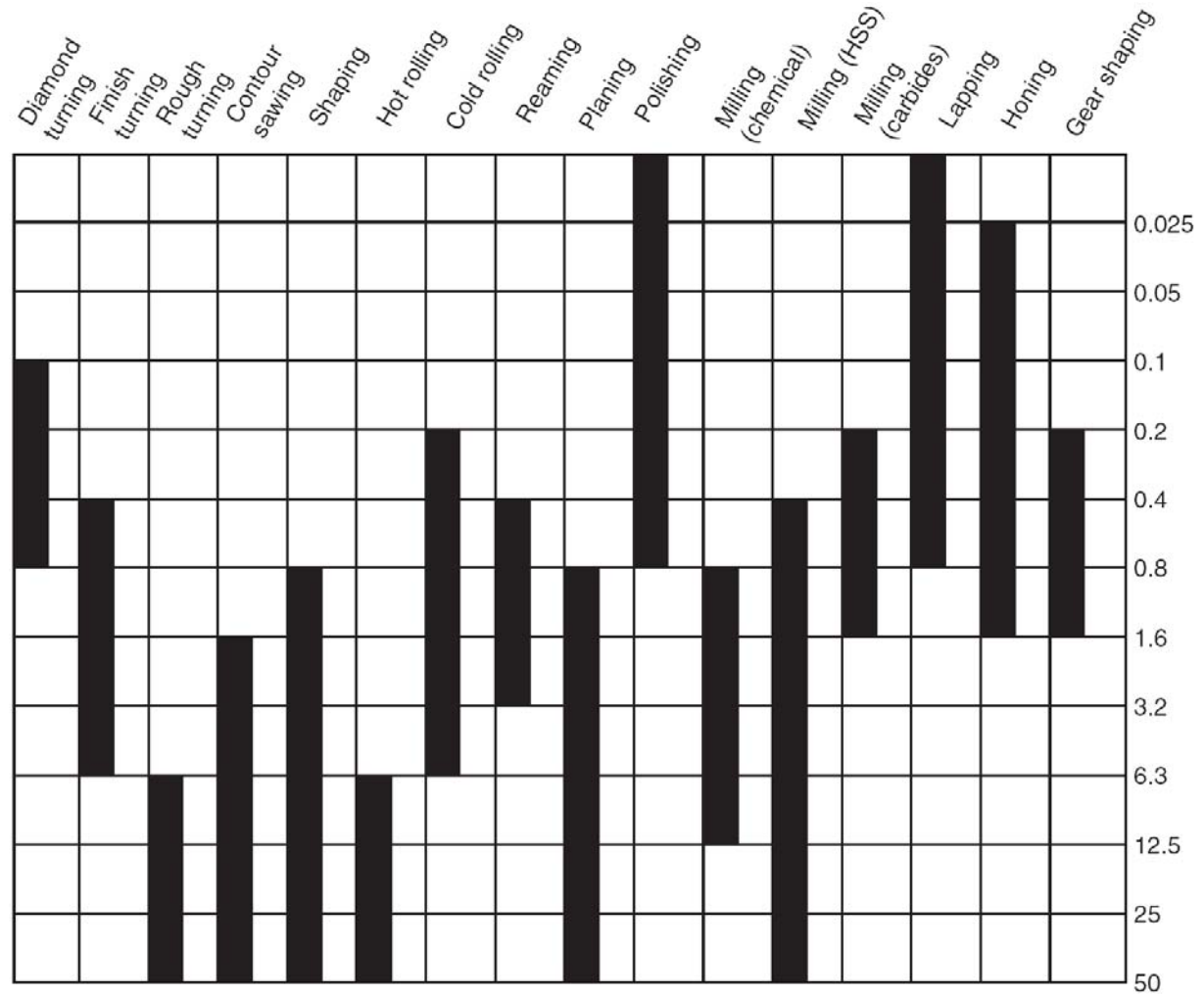
Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

Other information



Basics of technical drawing

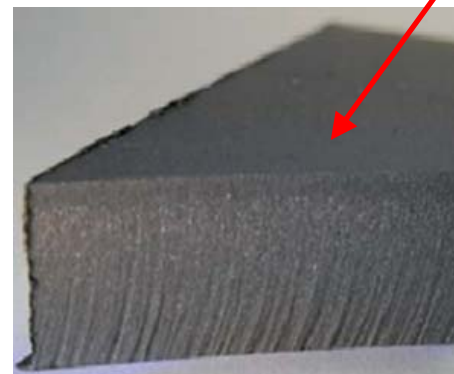
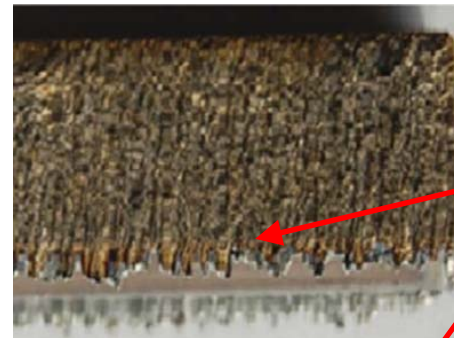
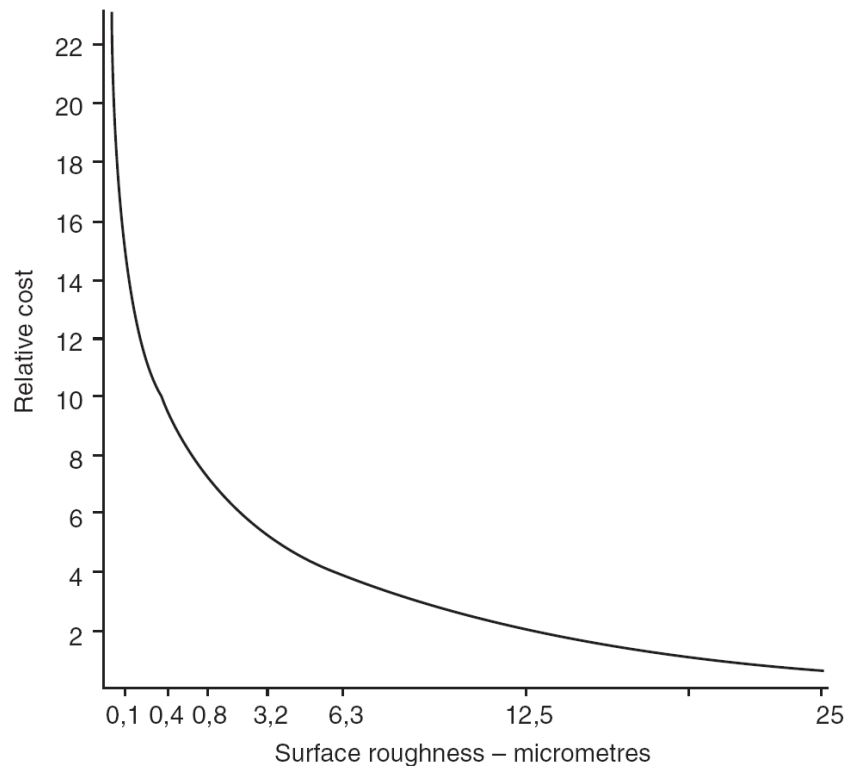
Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

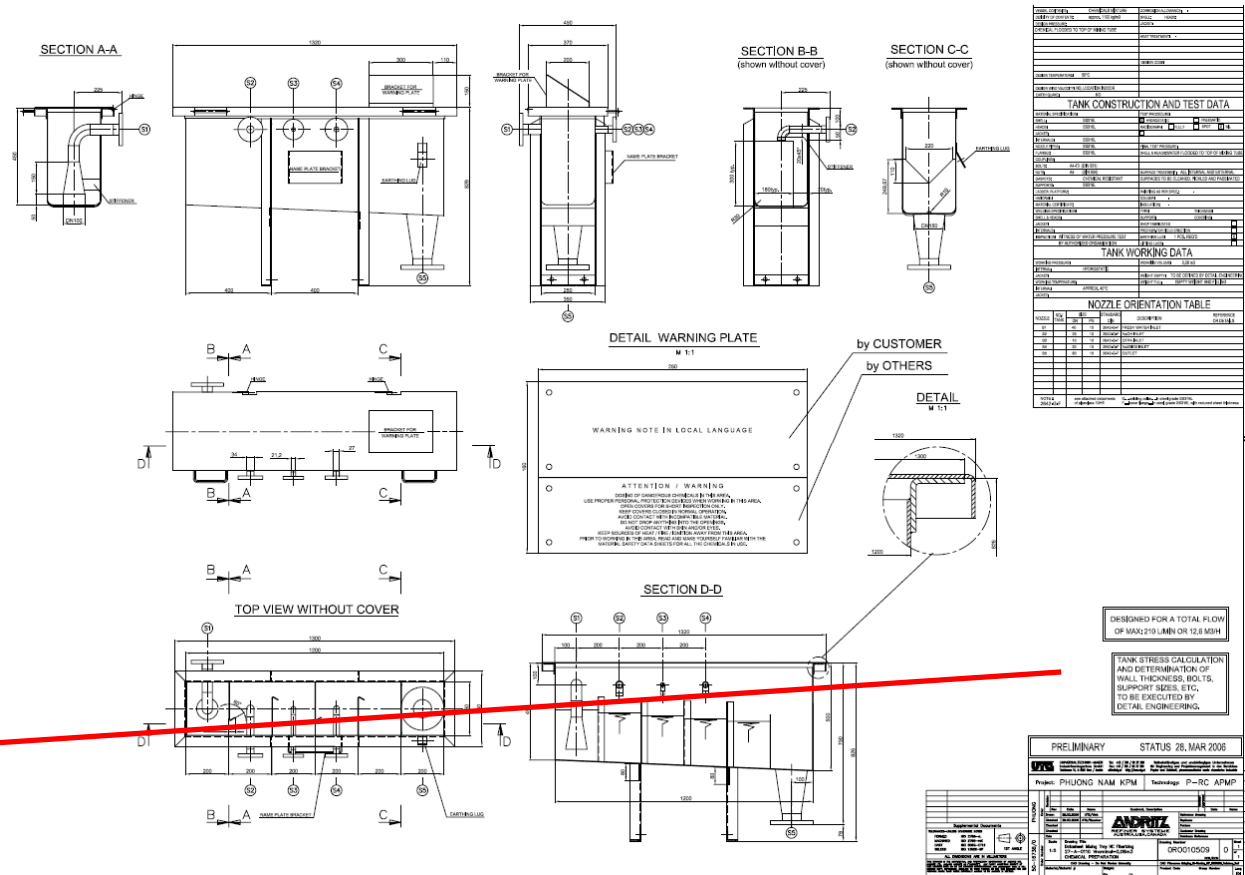
Other information



Plazma
Laser
AWJ

Basics of technical drawing

- Dimensioning
- Accuracy of dimensions
- Shape and position tolerances
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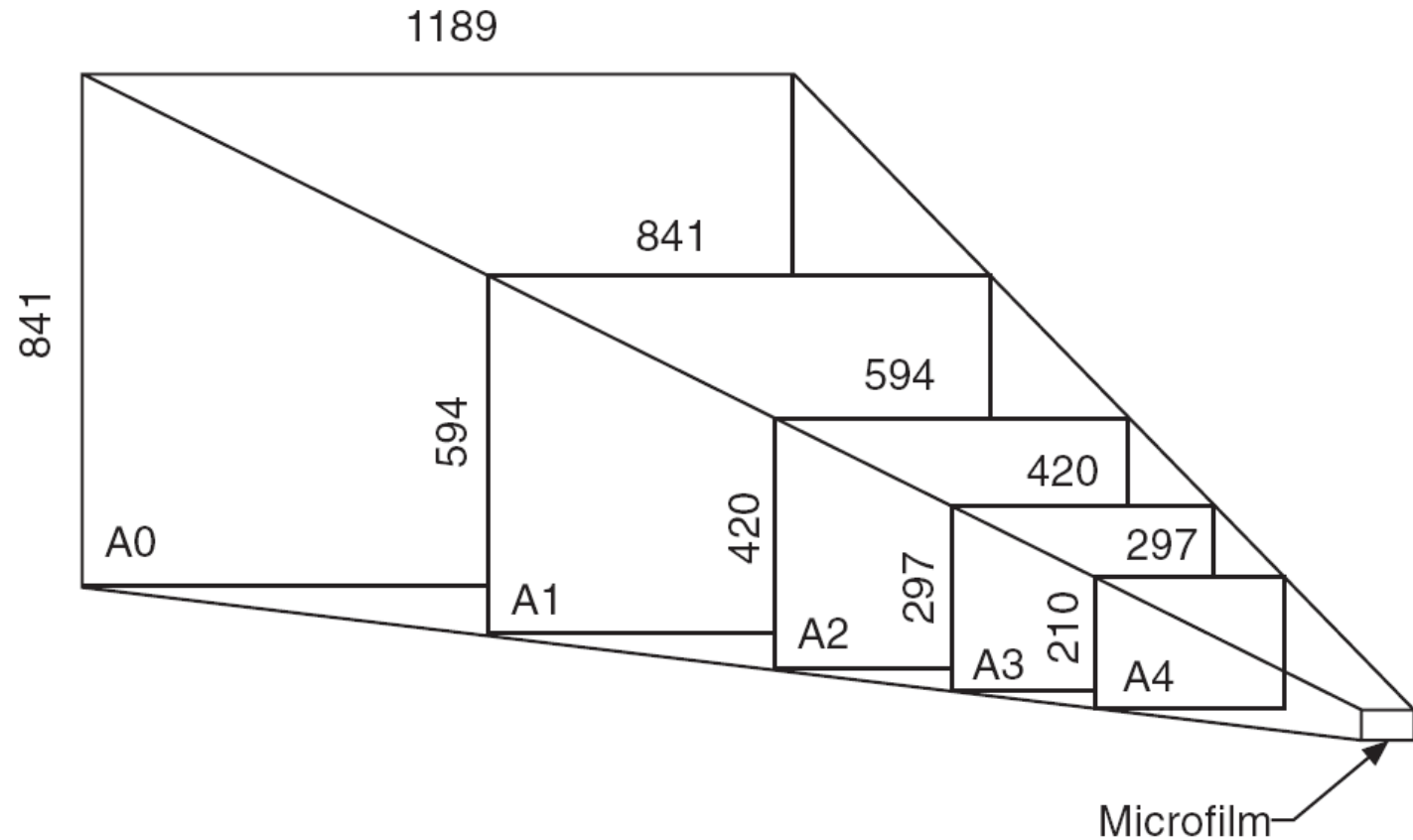


TANK STRESS CALCULATION AND DETERMINATION OF WALL THICKNESS, BOLTS, SUPPORT SIZES, ETC. TO BE EXECUTED BY DETAIL ENGINEERING.

Basics of technical drawing

Drawing space /
Paper form, paper
space/





Browser / online,
offline/



Basics of technical drawing

Drawing space / Paper form, paper space/






Browser / online, offline/

Example	Description & Representation	Application
A	Continuous wide line 	Visible edges and outlines
B	Continuous narrow line 	<ol style="list-style-type: none">1 Dimension, extension and projection lines2 Hatching lines for cross sections3 Leader and reference lines4 Outlines of revolved sections5 Imaginary lines of intersection6 Short centre lines7 Diagonals indicating flat surfaces8 Bending lines9 Indication of repetitive features
C	Continuous narrow irregular line 	Limits of partial views or sections provided the line is not an axis
D	Dashed narrow line 	Hidden outlines and edges

Basics of technical drawing

Drawing space / Paper form, paper space/

Browser / online, offline/

E	Long dashed dotted narrow line 	<ol style="list-style-type: none"> 1 Centre lines. 2 Lines of symmetry 3 Pitch circle for gears 4 Pitch circle for holes
F	Long dashed dotted wide line 	Surfaces which have to meet special requirements
G	Long dashed dotted narrow line with wide line at ends and at changes to indicate cutting planes 	Note BS EN ISO 128-24 shows a long dashed dotted wide line for this application
H	Long dashed double dotted narrow line 	<ol style="list-style-type: none"> 1 Preformed outlines 2 Adjacent parts 3 Extreme positions of moveable parts 4 Initial outlines prior to forming 5 Outline of finished parts 6 Projected tolerance zones
J	Continuous straight narrow line with zig zags 	Limits of partial or interrupted views; Suitable for CAD drawings provided the line is not an axis

Basics of technical drawing

Drawing space / Paper
form, paper space/

Browser / online, offline/

Autodesk online Viewer
Autodesk Navis Freedom

Hexagon Design review

 **AUTODESK** Viewer

Design Views

