Design of Process Equipment Basics of technical drawing

Lecture

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

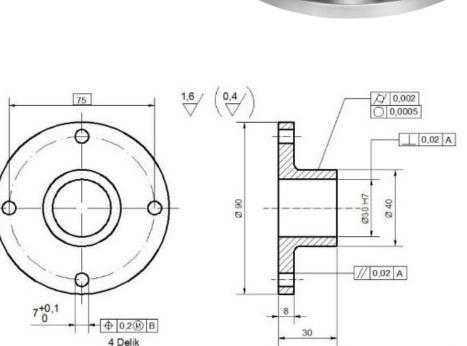
To translate a technical idea into an understandable language for others in the form of a technical drawing.

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

How much information do I need?

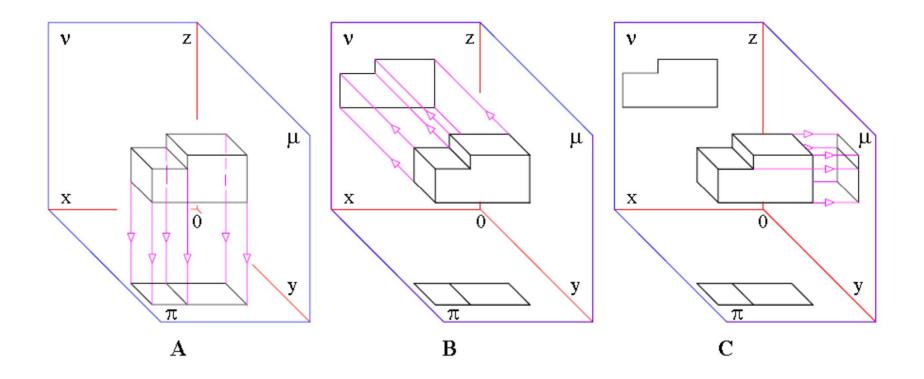
View (View) Cut (A-A, Section) Detail (Detail)

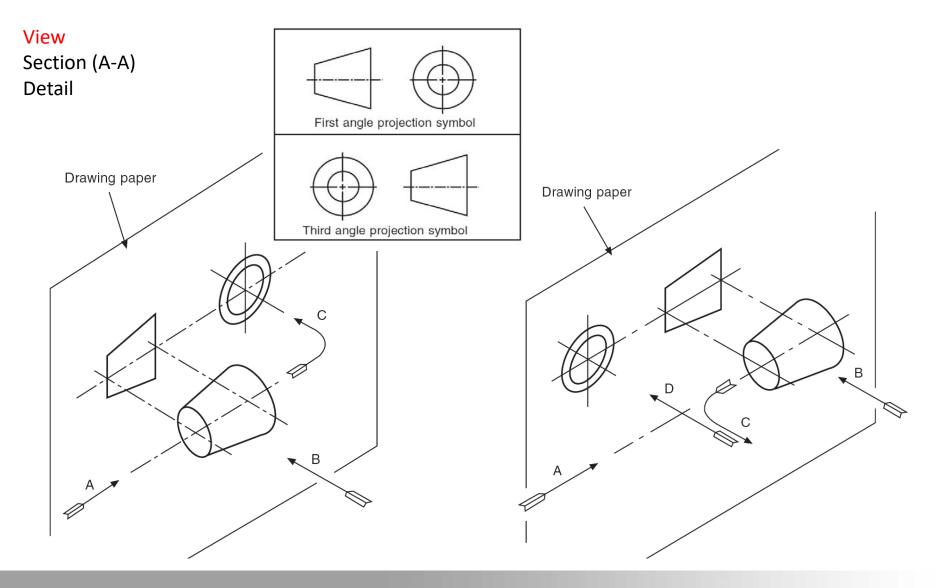
B, Additive information to ensure manufacturability and functionality.





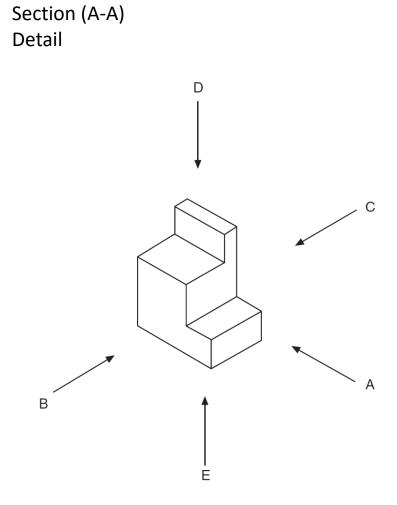
View

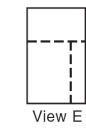


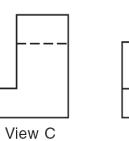


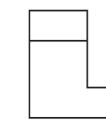
View

Basics of technical drawing



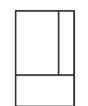




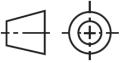


View A

View B



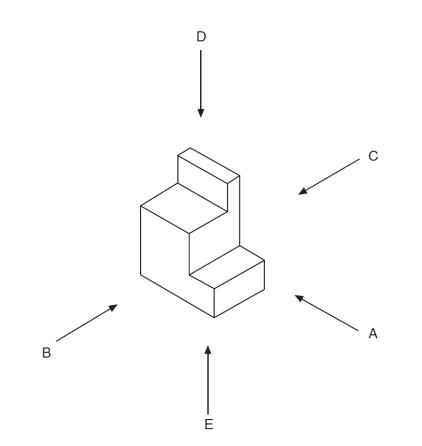
View D

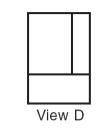


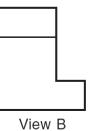
Projection symbol

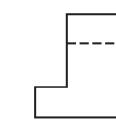


Section (A-A) Detail



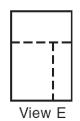






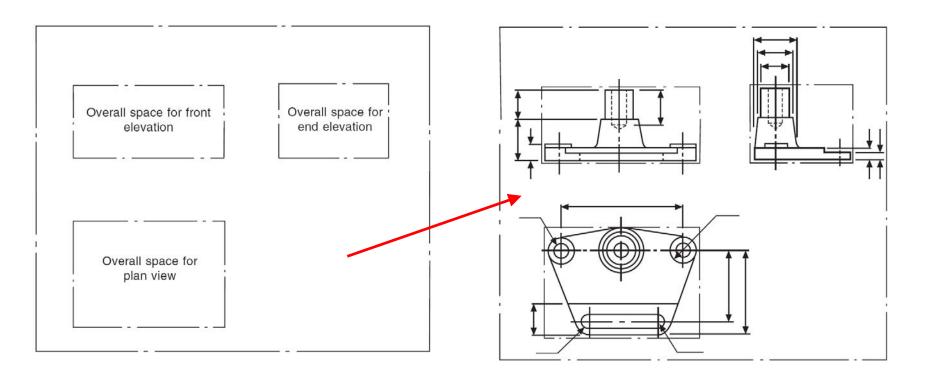


View C

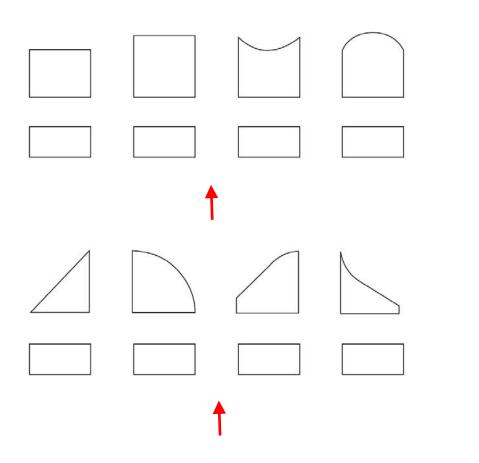


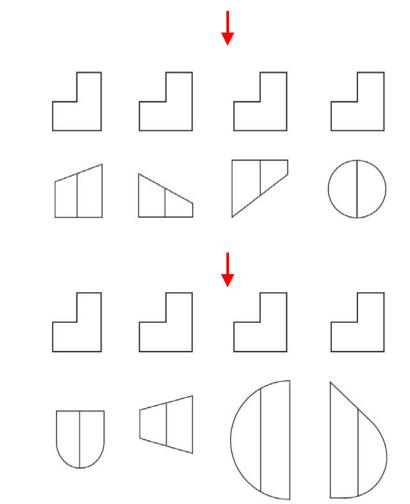
Projection symbol

View

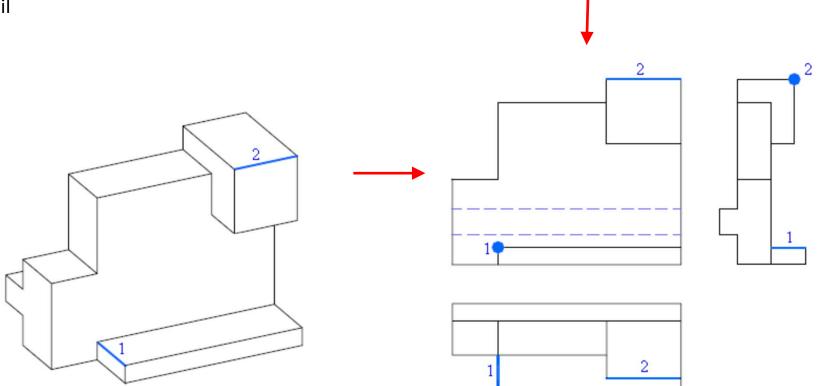


View





View



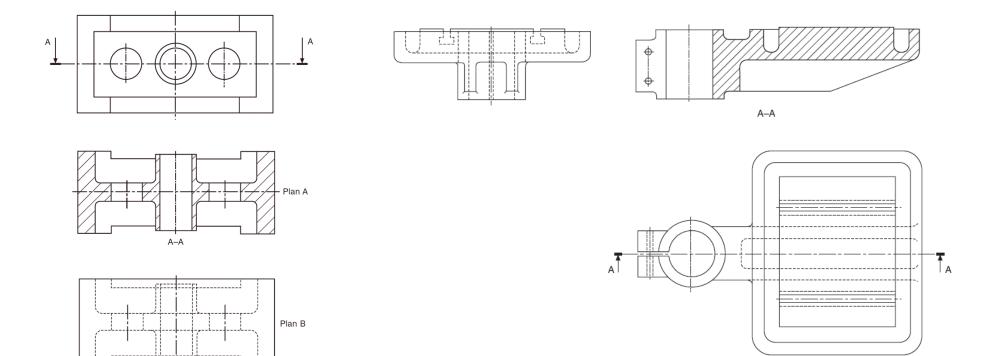




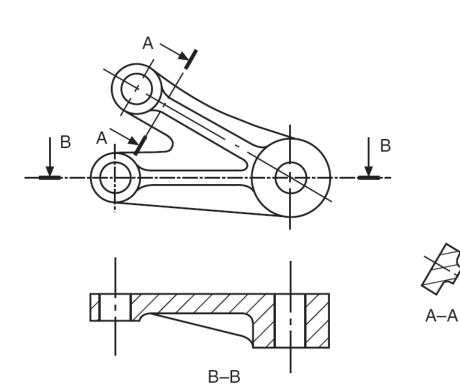
View

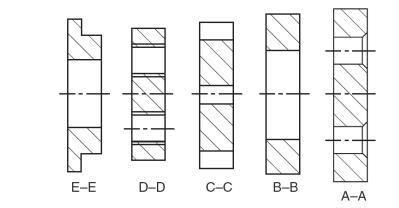


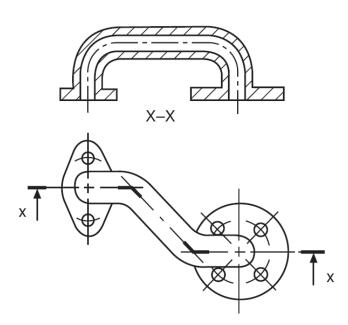
Detail

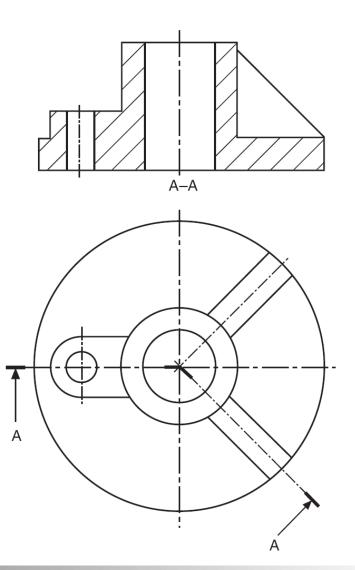


View Section (A-A) Detail





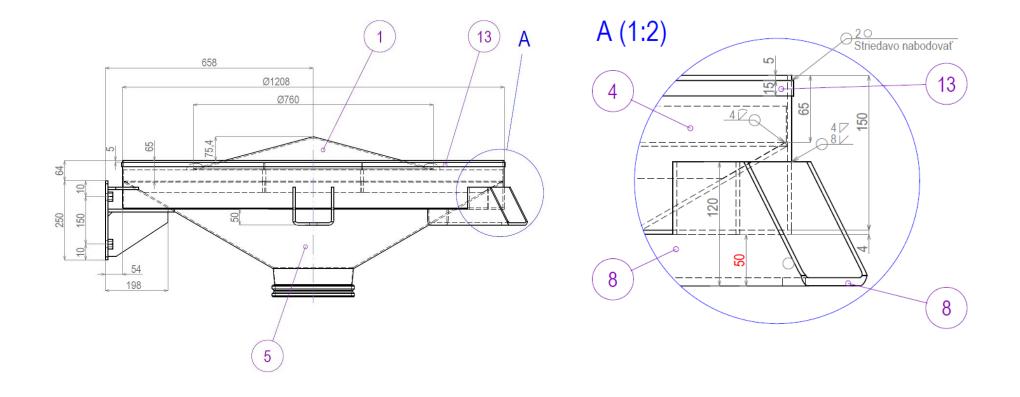




View

Section (A-A)

Detail



View Section (A-A) Detail

When is detail necessary?

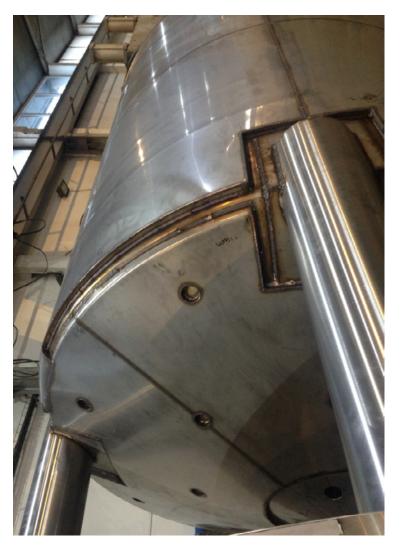
A complex or confusing construction node

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

Details of nozzles and inlets

Weld details





View Section (A-A) Detail

When is detail necessary?

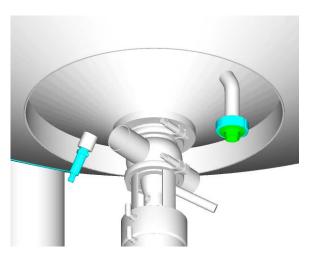
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A structural node that moves (e.g. hinges)

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Weld details

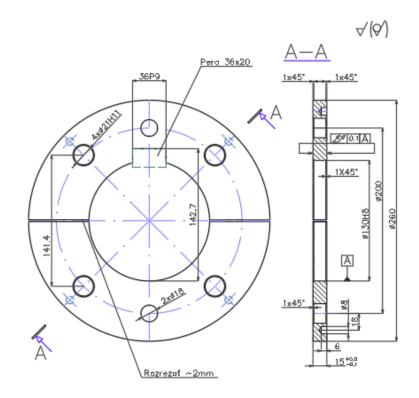




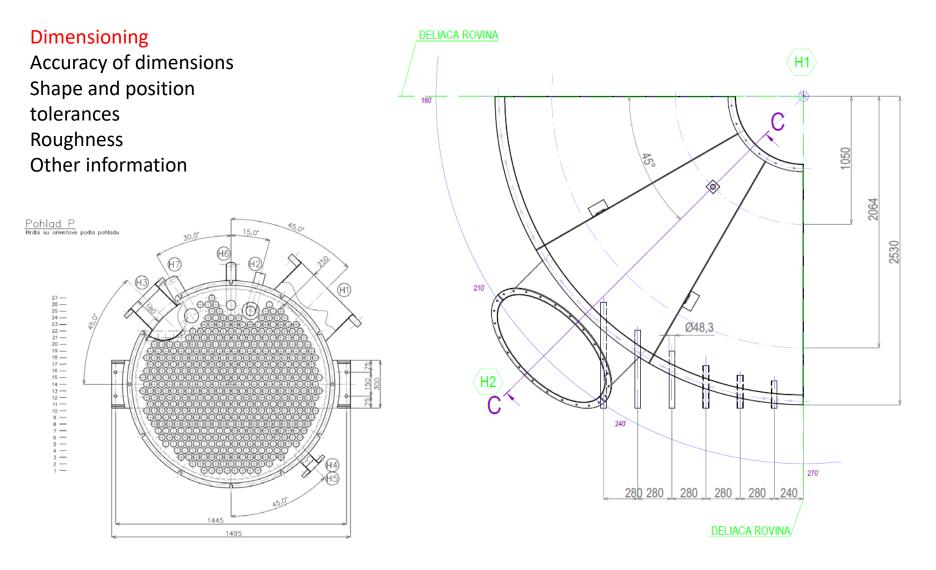


B, Additive information to ensure manufacturability and functionality.

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

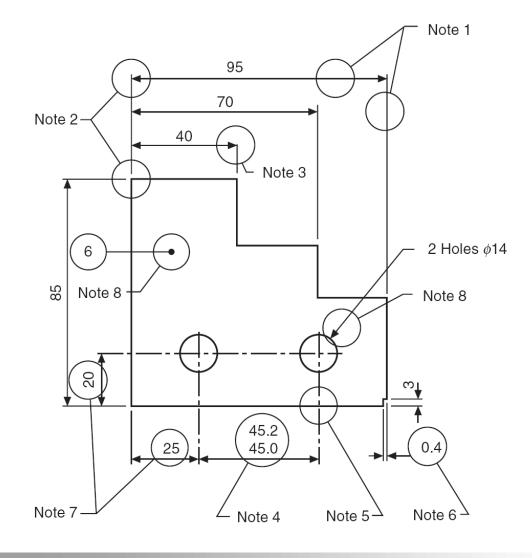


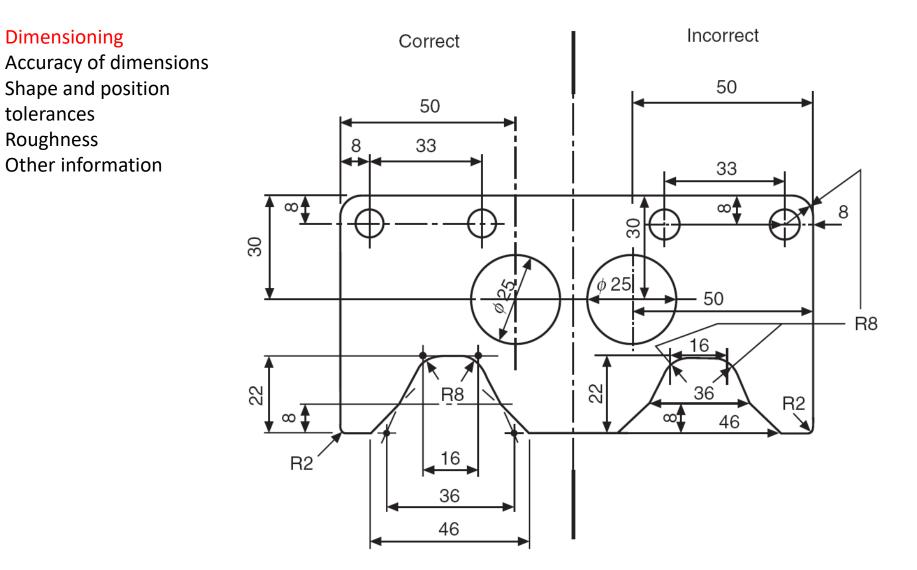
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Dimensioning

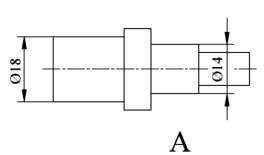
Accuracy of dimensions Shape and position tolerances Roughness Other information

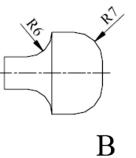


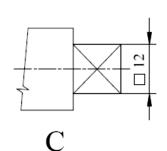


Dimensioning

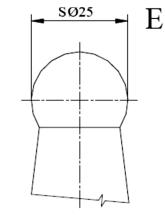
Accuracy of dimensions Shape and position tolerances Roughness Other information







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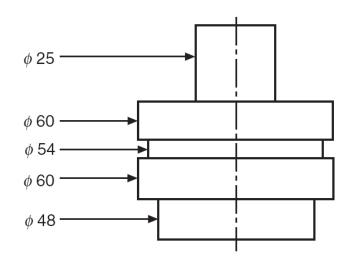


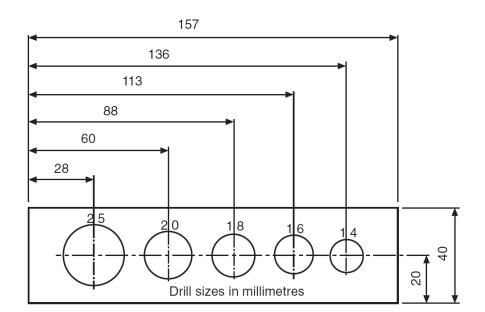
Dimensioning

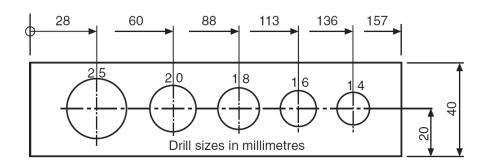
Accuracy of dimensions Shape and position tolerances

Roughness

Other information

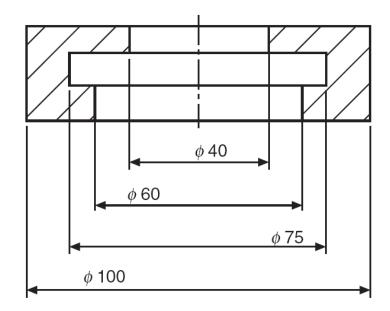


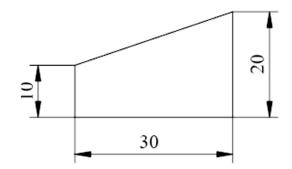


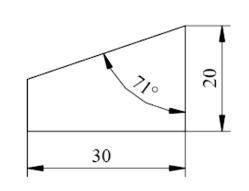


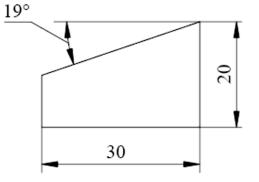
Dimensioning

Accuracy of dimensions Shape and position tolerances Roughness Other information



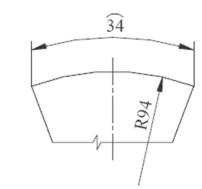


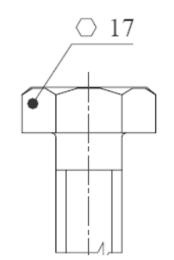


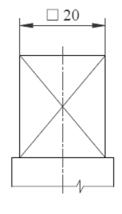


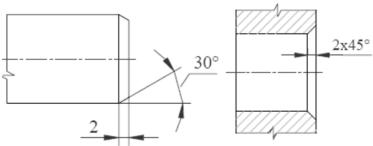
Dimensioning

Accuracy of dimensions Shape and position tolerances Roughness Other information

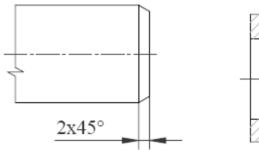


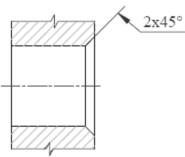


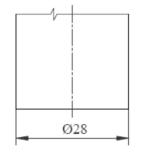


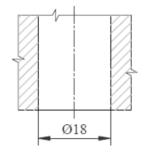


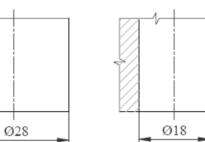


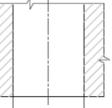












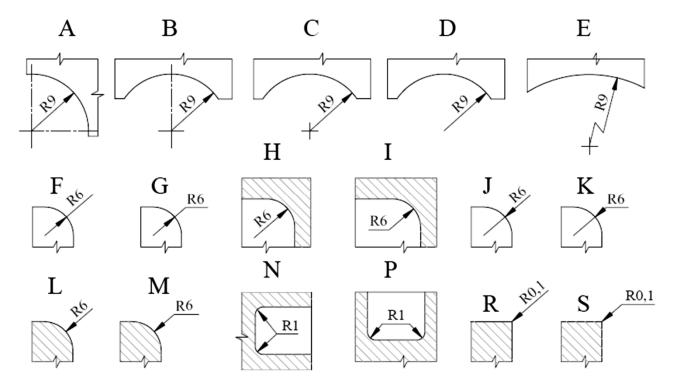
Dimensioning

Accuracy of dimensions Shape and position

tolerances

Roughness

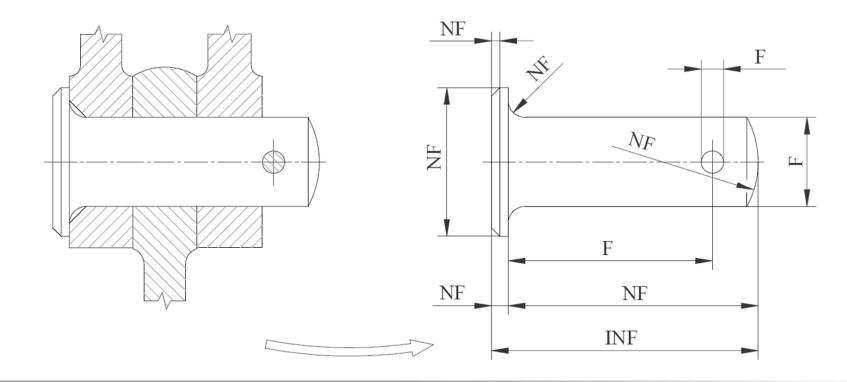
Other information

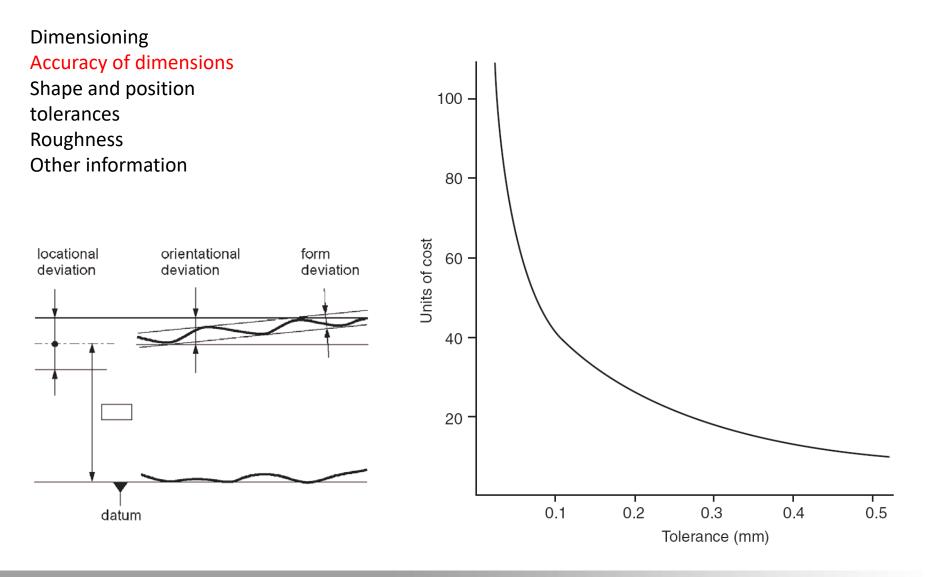


Dimensioning

Accuracy of dimensions Shape and position tolerances Roughness Other information

F – functional NF – non-functional INF - informative



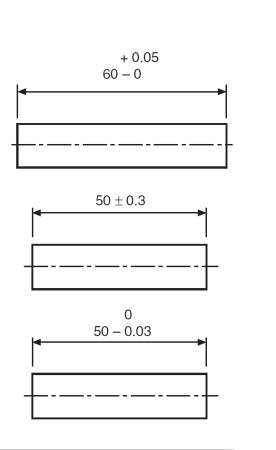


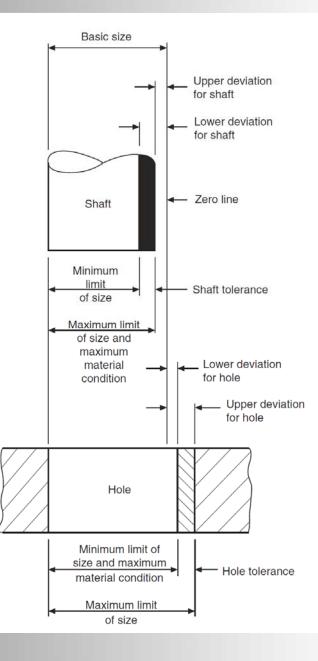
Dimensioning

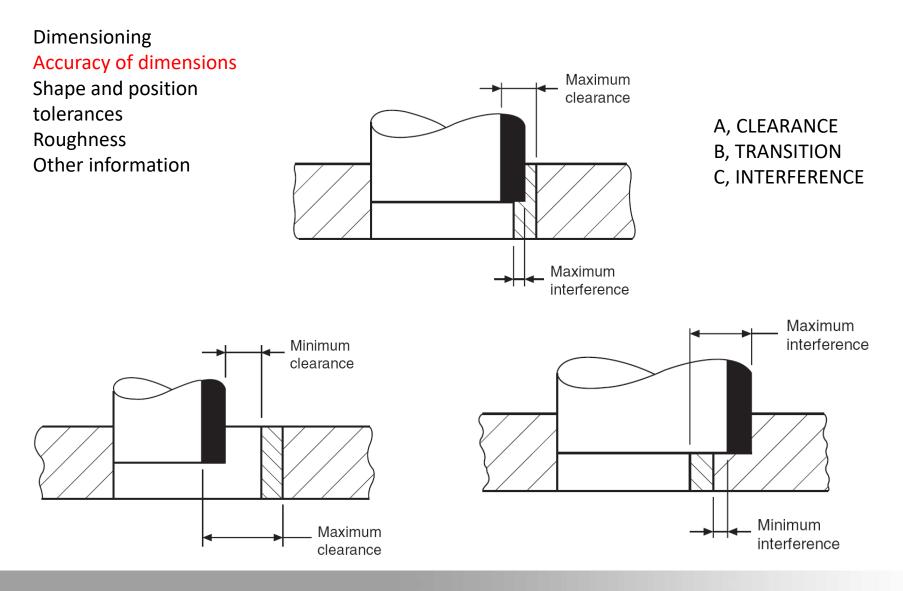
Accuracy of dimensions

Shape and position tolerances Roughness

Other information



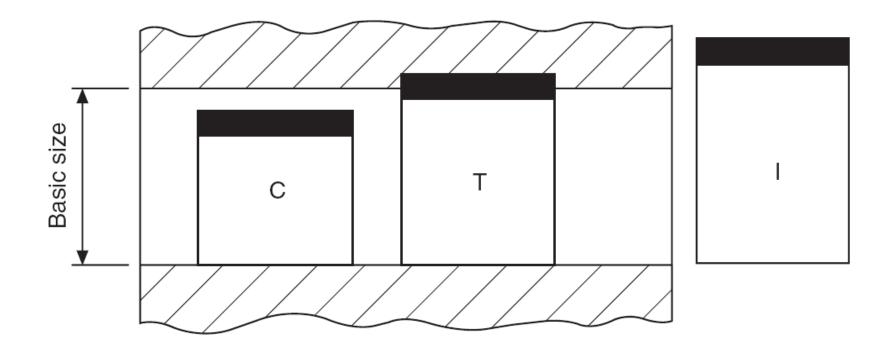




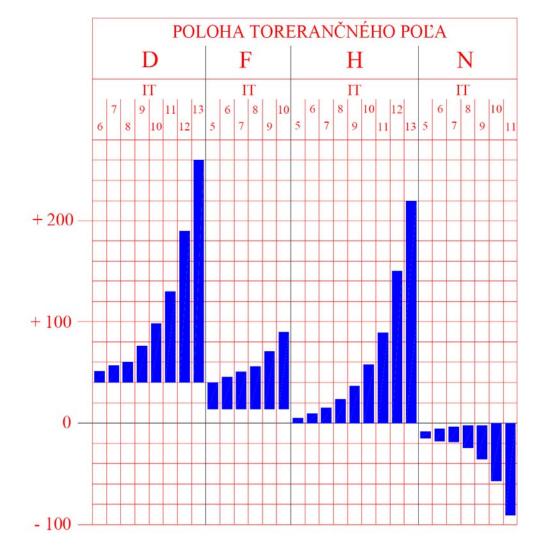
Dimensioning Accuracy of dimensions Shape and position tolerances Roughness

Other information

A, CLEARANCE B, TRANSITION C, INTERFERENCE



Dimensioning Accuracy of dimensions Shape and position tolerances Roughness Other information



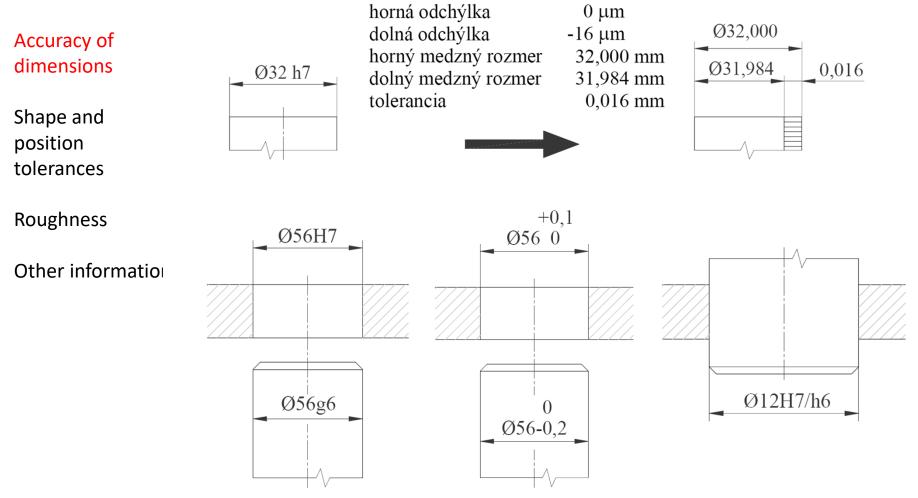
Dimensioning		Extracted from BS 4500 : 1969 BRITISH STANDARD BS 4500 : 1969 BRITISH STANDARD SELECTED ISO FITS—HOLE BASIS Low 1. February 1970 confirmed August 1988												A 1970										
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		3	0	- 120	+ 25 0	- 20 - 60	+ 25 0	- 14 - 39	0	- 16	0	- 8	0	0	0	+ 0	0	+4	0	+ 12 + 6	+ 10 0	+ 20 + 14	-	3
Roughness	3	6	+ 75 0 + 90 0	- 70 - 145 - 80	+ 30 0 + 36 0	= 30 - 78 - 40 - 98	+ 30 0 + 36 0	- 20 - 50 - 25 - 61	+ 18 0 + 22 0	- 10 - 28 - 13	+ 12 0 + 15 0	-4 -12	+ 12 + 15 0	- 8 0	+ 12 0 + 15 0	+ 9 + 1 + 10	+ 12 + 15 0	+ 16 + 8 + 19	+ 12 0 + 15	+ 20 + 12 + 24	+ 12 0 + 15 0	+ 27 + 19 + 32	3	6
110 0.8.11000	<u>6</u> 10	10	0 + 110 0	- 80 - 170 - 95 - 205	0 + 43 0	- 98 - 50 - 120	0 + 43 0	- 61 - 32 - 75	0 + 27 0	- 13 - 28 - 16 - 34	0 + 18 0	-5 -14 -6 -17	+ 18	-9 0 -11 0	0 + 18 0	+ 10 + 1 + 12 + 1	0 + 18 0	+ 19 + 10 + 23 + 12	+ 15 0 + 18 0	+ 24 + 15 + 29 + 18	0 + 18 0	+ 32 + 23 + 39 + 28	6	10
	18	18 30	0 + 130 0	- 205 - 110 - 240	0 + 52 0	- 120 - 65 - 149	0 + 52 0	- 75 - 40 - 92	0 + 33 0	- 34 - 20 - 41	0 + 21 0	- 17 - 7 - 20	0 + 21 0	0 - 13 0	0 + 21 0	+ 1 + 15 + 2	0 + 21 0	+ 12 + 28 + 15	0 + 21 0	+ 18 + 35 + 22	0 + 21 0	+ 28 + 48 + 35	10	18 30
	30	40	0 + 160 0	- 240 - 120 - 280					14		0												30	40
Other	40	50	0 + 160 0	- 280 - 130 - 290	+ 62	- 80 - 180	+ 62	- 50 - 112	+ 39 0	- 25 - 50	+ 25	- 9 - 25	+ 25	- 16 0	+ 25 0	+ 18 + 2	+ 25	+ 33 + 17	+ 25 0	+ 42 + 26	+ 25	+ 59 + 43	40	50
	50	65	+ 190	- 290 - 140 - 330	+ 74	- 100	- 74	- 60	+ 46	- 30	+ 30	- 10	+ 30	- 19	+ 30	+ 21	+ 30	+ 39	+ 30	+ 51	+ 30	+ 72 + 53	50	65
information	65	80	+ 190	- 150 - 340	0	- 220	0	- 134	0	- 60	0	- 29	0	0	0	+2	0	+ 20	0	+ 32	+ 30	+ 78 + 59	65	80
	80	100	+ 220	- 170 - 390	+ 87	~ 120	- 87	- 72	+ 54	- 36	+ 35	- 12	+ 35	- 22	+ 35	+ 25	+ 35	+ 45	+ 35	+ 59	+ 35	+ 93 + 71	80	100
	100	120	+ 220	- 180 - 400	+ 0	- 260	- 0	- 159	0	- 71	0	- 34	0	0	0	+ 3	0	+ 23	0	+ 37	+ 35 + 0	+ 101 + 79	100	120
	120	140	+ 250	- 200 - 450																	+ 40	+ 117 + 92	120	140
	140	160	+ 250	- 210 - 460	+ 100 0	145 305	+ 100 0	- 84 - 185	+ 63	- 43 - 83	- 40 0	- 14 - 39	+ 40 0	-25	+ 40 0	+ 28 + 3	+ 40 0	+ 52 + 27	- 40 0	+ 68 + 43	+ 40 0	+ 125 + 100	140	160
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	180	200	+ 290	- 240 530	1.778		1.12	222	1.00	02		1.1		1.1	222					1.00	+ 46	+ 151 + 122	180	200
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	250	280	+ 320 0 + 320	300 620	+ 130	- 190 - 400	+ 130	- 110 - 240	+ 81	- 56 - 108	+ 52	- 17 - 49	+ 52	+ 32	+ 52	- 36	+ 52	+ 66 + 34	+ 52	+ 88 + 56	+ 52	+ 190 + 158	250	280
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BRITISH STANDARDS INSTITUTION, 2 Park Street, London, W1A 2BS SBN: 580 05766 6

Dimensioning		xtracted from 500 : 1			BRITISH STANDARD SELECTED ISO FITS—SHAFT BAS											SIS Issue				Data Sh 4500 ne 1. Februa	В			
Accuracy of dimensions	Diagra scale 25 mm. d	for		C 11	D 1	0	E 9	Clearan	F 8		G	\mathbb{Z}		17		К7	ition fits			Interfe	rence fits			Toles
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		2	0	+ 120 + 60	0	+ 60 + 20	0 - 25	+ 39	0	+ 20 + 6	0	+ 12 + 2	0.001 1111	+ 10	0	0	0	- 4	0	- 6	0	- 14 - 24		
	3	6	- 60 - 75	+ 60 + 145 + 70	- 25 0 - 30	+ 20 + 78 + 30	- 25 0 - 30	+ 14 + 50 + 20	- 10 0 - 12	+ 6 + 28 + 10	- 6 0	+ 2 + 16 + 4	- 6	0 + 12 0	- 6	- 10 + 3 - 9	-6	- 14 - 4 - 16	- 6 0 - 8	- 16 - 8 - 20	- 6 0	- 24 - 15 - 27	3	<u>3</u> 6
Roughness	6	10		+ 170 + 80	- 36	+ 98 + 40	- 30	+ 20 + 61 + 25	0	+ 35 + 13		+ 20 + 5	0	+ 15	0	+ 5	0 - 9	- 16 - 4 - 19	0		0	- 17	6	10
110 0.8.11000	10	18	0 - 110	+ 205	0 - 43	+ 120 + 50	0 - 43	+ 75 + 32	0 - 18	+ 43 + 16	0	+ 24 + 6	0	+ 18	0	+ 6 - 12	0	-5 -23	0 - 11	- 11 - 29	0 - 11	- 21 - 39	10	18
	18	30		+ 240 + 110	0 - 52	+ 149 + 65	0 - 52	+ 92 + 40	0 - 21	+ 53 + 20	0 - 13	+ 28 + 7	0 - 13	+ 21	- 13	+ 6 - 15	0 - 13	-7 -28	- 13	- 14 - 35	0 - 13	- 27 - 48	18	30
Other	$\frac{30}{40}$	40 50		+ 280 + 120 + 290 + 130	0 - 62	+ 180 + 80	0 - 62	+ 112 + 50	0 - 25	+ 64 + 25	0 - 16	+ 34 + 9	0 - 16	+ 25 0	0 - 16	+ 7 - 18	0 - 16	- 8 - 33	0 - 16	- 17 - 42	0 - 16	- 34 - 59	30 40	40 50
:f	50	65	0 - 190	+ 330 + 140	0 - 74	+ 220	0	+ 134	0	+ 76	0	+ 40	0	+ 30	0	+ 9	0	- 9	0	- 21	0 - 19	- 42 - 72	50	65
information	65	80		+ 340 + 150	- /4	+ 100	~ 74	+ 60	- 30	+ 30	- 19	+ 10	- 19	0	- 19	- 21	- 19	- 39	- 19	- 51	0 - 19	- 48 - 78	65	80
	80	100	0 - 220 - 220	+ 390 + 170 + 400 + 800	0	+ 260 + 120	0 - 87	+ 159 + 72	0 - 35	+ 90 + 36	0 - 22	+ 47 + 12	0 - 22	+ 35	0 - 22	+ 10 - 25	0 - 22	- 10 - 45	0	- 24 - 59	0 - 22 0 - 22	- 58 - 93 - 66 - 101	80	100
	<u>100</u> 120	120 140	- 220 0 - 250	+ 800 + 450 + 200						1											-22 0 -25	- 101 - 77 - 117	100 120	120 140
	140	140	- 250 - 250	+ 200 + 460 + 210	0 - 100	+ 305 + 145	- 100	+ 185 + 85	0 - 40	+ 106 + 43	- 25	+ 54 + 14	- 25	+ 40	- 25	+ 12 - 28	0 - 25	- 12 - 52	- 25	- 28	- 25 0 - 25	- 117 - 85 - 125	140	160
	160	180	0 - 250	+ 480 + 230	- 100	+ 145	- 100	+ 65	- 40	+ 45	- 40	3,13	- 23		- 43	- 28	- 23	7.26	- 23	- 00	0 - 25	- 93 - 133	160	180
	180	200	0 - 290	+ 530 + 240																	0 - 29	- 105 - 151	180	200
	200	225	0 - 290	+ 550 - 260	- 115	+ 355 + 170	- 115	+ 215 + 100	0 - 46	+ 122 + 50	0 - 29	+ 61 + 15	0 - 29	+ 46	0 - 29	+ 13 - 33	0 - 29	- 14 - 60	0 - 29	- 33 - 79	0 - 29	- 113 - 159	200	225
	225	250	- 290	+ 570 + 280	-												-				0 - 29	- 123 - 169	225	250
	250	280	- 320	+ 620 + 300 + 650	0 - 130	+ 400 + 190	0	+ 240 + 110	0	+ 137 + 56	0	+ 62 + 17	0	+ 52	0 - 32	+ 16	0	- 14	0	- 36	0 - 32	- 138 - 190 - 150	250	280
	<u>280</u> 315	315	0 - 320 0 - 360	+ 650 + 330 + 720 + 360						1.000				-	11.924638-						-32 0 -36	- 150 - 202 - 169 - 226	280 315	315 355
	315	400	- 360 - 360	+ 360 + 760 + 400	0 - 140	+ 440 + 210	0 - 140	+ 265 + 125	0 - 57	+ 151 + 62	0 - 36	+ 75 + 18	0 - 36	+ 57 0	0 - 36	+ 17 - 40	0 - 36	- 16 - 73	0 - 36	- 41 - 98	- 36 0 - 36	- 226 - 187 - 244	315	400
	400	450	- 300 0 - 400	+ 400 + 840 + 440	0	+ 480	0	+ 290	0	+ 165	0	+ 83	0	+ 63	0	+ 18	0	- 17	0	- 45	- <u>30</u> - 40	- 244 - 209 - 272	400	450
	450	500	- 400	+ 880 + 480	- 155	+ 230	- 155	+ 135	- 63	+ 68	- 40	+ 20	- 40	0	- 40	- 45	- 40	- 80	- 40	- 108	0 - 40	- 229 - 292	450	500

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Dimensioning



Dimensioning

Accuracy of dimensions

Shape and position tolerances

Roughness

Volna tolerancia: /General allowance/ ISO 2768—mK

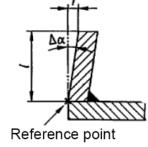
ISO 13920:2023 Welding - General tolerances for welded constructions -Dimensions for lengths and angles - Shape and position. ISO 2768-1:1989 General tolerances,. Part 1: Tolerances for linear and angular dimensions without individual tolerance indications

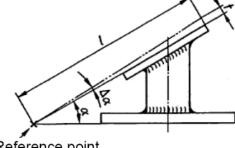
Other information

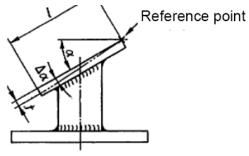
Tolerance cla	Permissible deviations for basic size range											
Designation	Description	from 0,5* up to 3	over 3 up to 6	over 6 up to 30	over 30 up to 120	over 120 up to 400	over 400 up to 1000	over 1000 up to 2000	over 2000 up to 4000			
f	fine	± 0,05	± 0,05	± 0,1	± 0,15	± 0,2	± 0,3	± 0,5				
m	medium	± 0,1	± 0,1	± 0,2	± 0,3	± 0,5	± 0,8	± 1,2	± 2			
С	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).											

Dimensioning

Accuracy of dimensions







position tolerances

Shape and

Reference point

Roughness

1. Tolerances for length dimensions

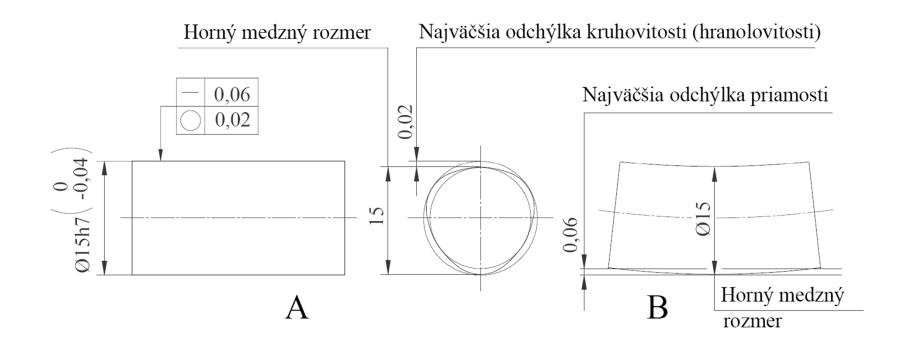
Other information

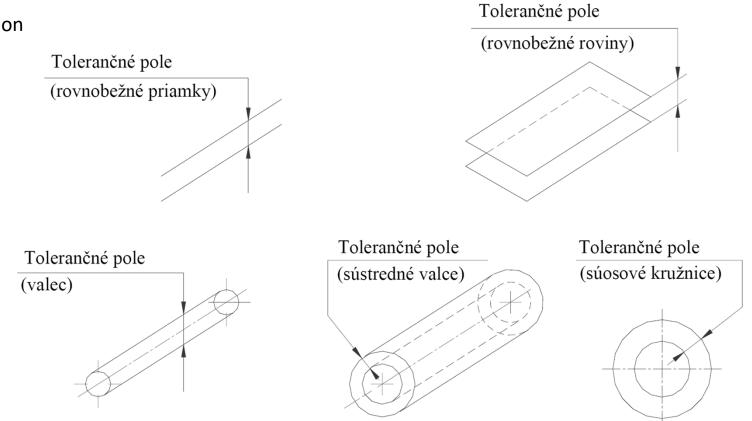
Length ranges	up to 400	over 400 - 1000	over 1000 - 2000	over 2000 - 4000
Tolerances	± 1.0	± 2.0	± 3.0	± 4.0

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

Dimensioning Accuracy of dimensions Shape and position tolerances Roughness Other information





Dimensioning

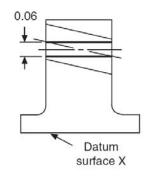
Symbols for geometrical characteristics

Accuracy of	Type of tolerance	Characteristics to be toleranced	Symbol	Datum needed	Applications
dimensions		Straightness		No	A straight line. The edge or axis of a feature.
Shape and		Flatness		No	A plane surface.
position tolerances	Form	Roundness	\bigcirc	No	The periphery of a circle.Cross-section of a bore, cylinder, cone or sphere.
Roughness		Cylindricity	$\langle Q \rangle$	No	The combination of circularity, straightness and parallelism of cylindrical surfaces. Mating bores and plungers.
Other		Profile of a line	\bigcirc	No	The profile of a straight or irregular line.
information		Profile of a surface	\bigcirc	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.

Dimensioning	Orientation	Angularity	\angle	Yes	The angular displacement of surfaces, axes, or lines from a datum.
Accuracy of dimensions		Profile of a line	\bigcirc	Yes	The profile of a straight or irregular line positioned by theoretical exact dimensions with respect to datum plane(s).
Shape and		Profile of a surface	\bigcirc	Yes	The profile of a straight or irregular surface positioned by theoretical exact dimensions with respect to datum plane(s).
position tolerances		Position	\oplus	See note below	The deviation of a feature from a true position.
	Location	Concentricity and coaxiality	\bigcirc	Yes	The relationship between two circles having a common centre or two cylinders having a common axis.
Roughness		Symmetry	<u> </u>	Yes	The symmetrical position of a feature related to a datum.
Other information		Profile of a line	\bigcirc	Yes	The profile of a straight or irregular line positioned by theoretical exact dimensions with respect to datum plane(s).
		Profile of a surface	\bigcirc	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	21	Yes	The relative position of a point when traversed along a surface rotating about its datum axis.

Dimensioning Accuracy of dimensions Shape and position tolerances Roughness Other information

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



0.06

Х

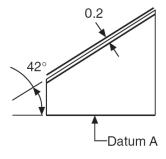
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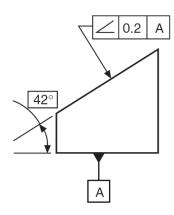
Drawing instruction

Angularity Parallelism Perpendicularity

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





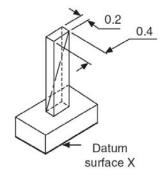
Dimensioning Accuracy of dimensions Shape and position tolerances Roughness Other information

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

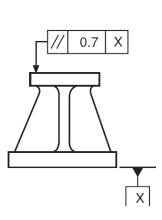
0.7 Datum surface X Angularity Parallelism Perpendicularity

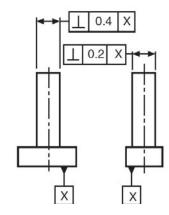
Product requirement The axis of the column must be contained in a tolerance-zone box 0.2×0.4 which is perpendicular to the datum surface X.

Drawing instruction



Drawing instruction

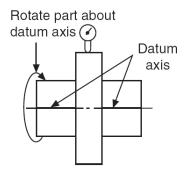




Dimensioning Accuracy of dimensions Shape and position tolerances Roughness Other information

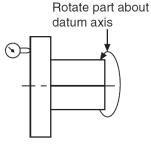
Product requirement

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.

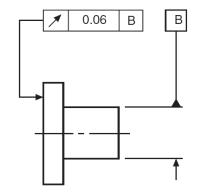


Circular runout

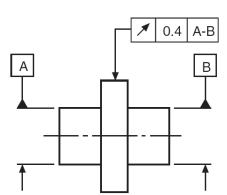
Product requirement At any radius, the circular run-out must not exceed 0.06 measured parallel to the datum axis.



Drawing instruction



Drawing instruction

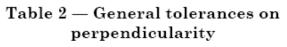


Dimensioning Accuracy of dimensions Shape and position tolerances Roughness Other information

Table 1 — General tolerances on straightness and flatness

Values in millimetres

Tolerance	Straightness and flatness tolerances for ranges of nominal lengths						
class	up to 10	over 10 up to 30	1	-	over 300 up to 1 000	-	
Н	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	

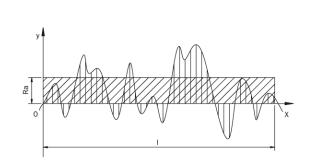


Values in millimetres

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

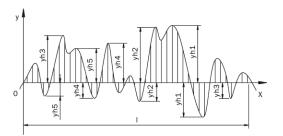


Dimensioning Accuracy of dimensions Shape and position tolerances Roughness Other information



Arithmetical mean roughness value Ra





Definition of Surface Roughness

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

The average roughness value Ra (µm)

if the arithmetical mean of the absolute values of profile fluctuation within roughness reference section I.

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 Ra value and the width is the length of the reference section. The Ra variable is the preferred variable.

The average roughness height (peak-to-valley height) Rz (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) Rmax (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 RSm, maximum profile peak height Rp or the maximum profile valley depth RM are not relevant to the food industry because of the transparency.

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, gemmation with galvanizing
5th order: Roughness not presentable	crystallization process, mordant, corrosion
6th order: Roughness	crystal structure
not presentable	
Superposition	actual surface

 $\sim\sim\sim\sim$

roughness or waviness profile

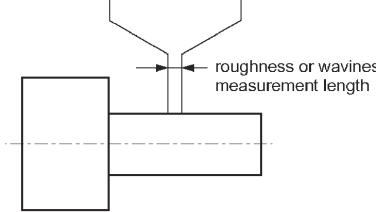
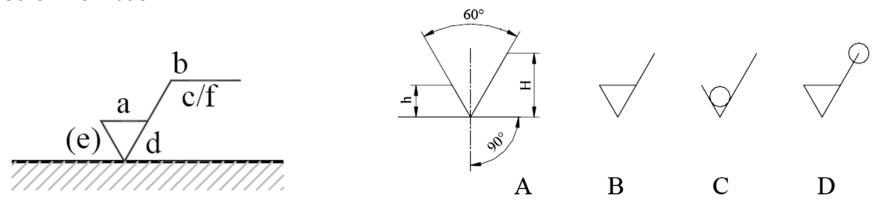
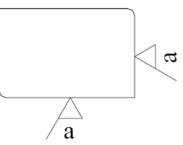
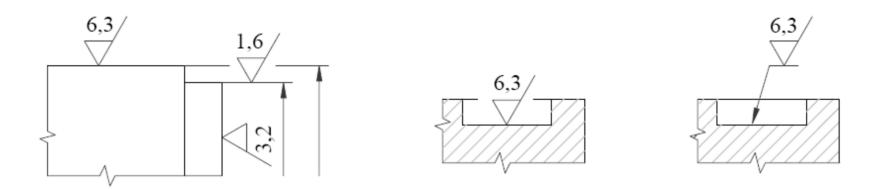


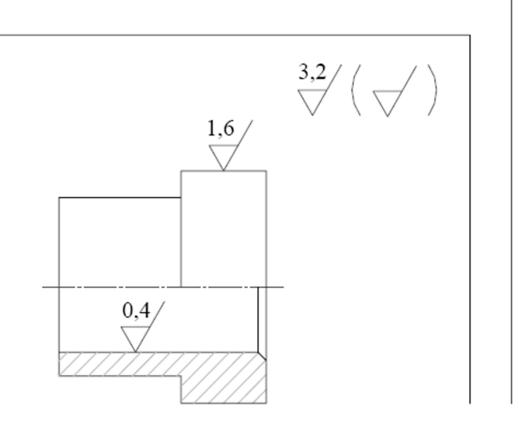
Fig. 1.5 Superposition of surface deviations (DIN 4760)

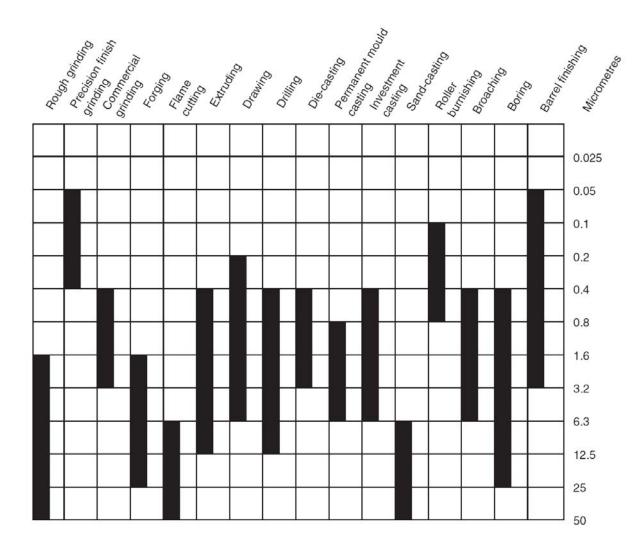


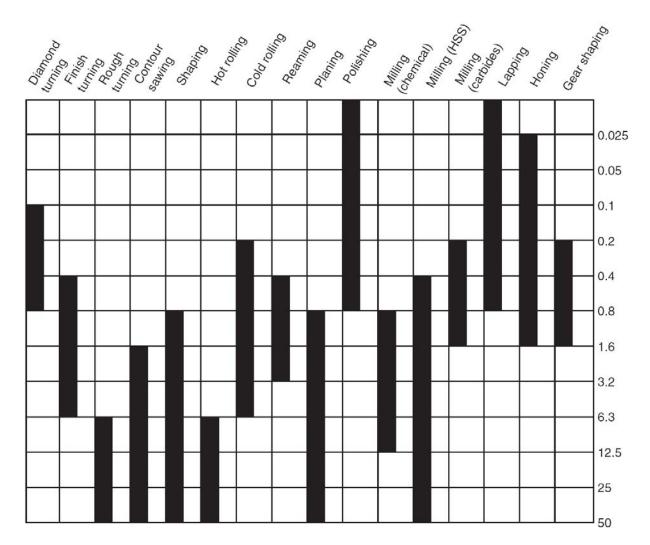
- a značka a číselná hodnota drsnosti Ra v mikrometroch,
- b spôsob konečného spracovania, výrobná metóda, opracovanie, úprava povrchu, atď.,
- c výška vlnitosti v mikrometroch, pred ktorou je uvedená značka parametra alebo základná dĺžka v milimetroch (pre R_a, R_z, R_y sa táto hodnota vynecháva),
- d značka smeru nerovnosti povrchu (C-kruhový, M-rôzny, X-skrížený v dvoch smeroch,
 =-rovnobežný 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_v 0,4.

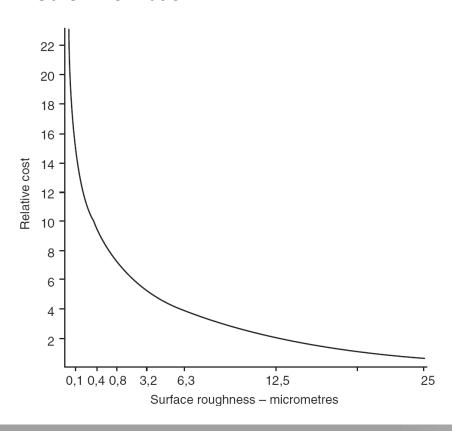


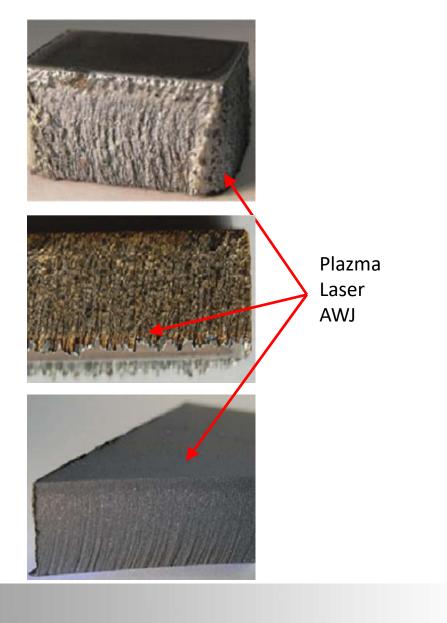


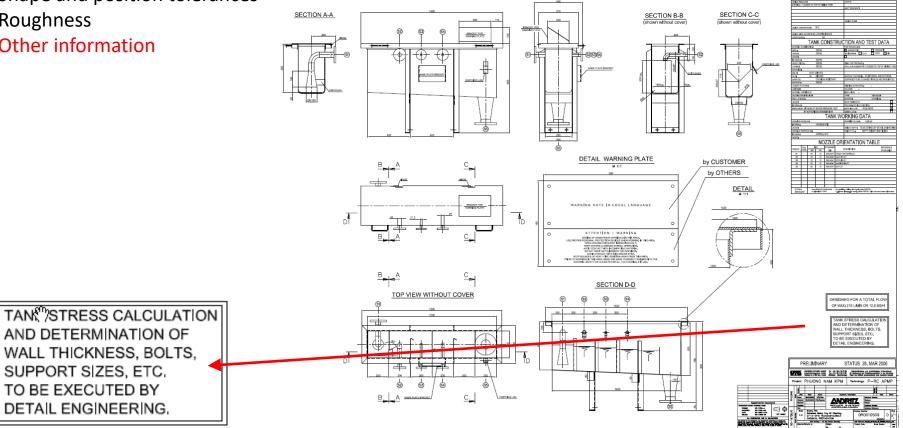


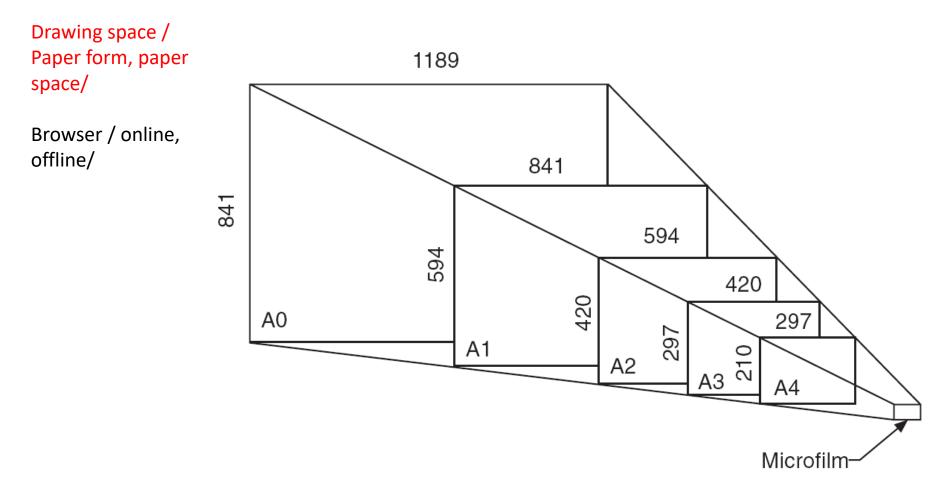












Drawing space / Paper form, paper space/

Browser / online, offline/

Description & Representation	Application
Continuous wide line	Visible edges and outlines
Continuous narrow line	1 Dimension, extension and projection lines
	2 Hatching lines for cross sections
	3 Leader and reference lines
	4 Outlines of revolved sections
	5 Imaginary lines of intersection
	6 Short centre lines
	7 Diagonals indicating flat surfaces
	8 Bending lines
	9 Indication of repetitive features
Continuous narrow irregular line	Limits of partial views or sections provided the line is not an axis
Dashed narrow line	Hidden outlines and edges
Da	ashed narrow line

Drawing space / Paper form, paper space/

Browser / online, offline/

Е	Long dashed dotted narrow line	 Centre lines. Lines of symmetry Pitch circle for gears 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	 Preformed outlines Adjacent parts Extreme positions of moveable parts Initial outlines prior to forming Outline of finished parts Projected tolerance zones
1	Continuous straight narrow line with zig zags	Limits of partial or interrupted views; Suitable for CAD drawings provided the line is not an axis

Drawing space / Paper form, paper space/

Browser / online, offline/

Autodesk online Viewer Autodesk Navis Freedom

Hexagon Design review

AUTODESK Viewer



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