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Basic rules for creating drawing documentation

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The CAD data purity

When creating 3D, 2D drawings, BOMs, etc., it is necessary to observe certain principles that allow them to effective work with them. There are no general principles. Each company creates these principles with respect to product, technology, size, business relationships…. The aim of "data purity" must be intelligible, clear for the whole team (company).

CAD documentation numbering

- The numbering of CAD documentation is given by the type of company and its possibilities. For data management it is possible to use PLM, PDM system.

- The drawing number and model number should be identical to the drawing. The drawing model is one part.

Technical drawings - selected standards

- EN ISO 128-20 **Technical drawings** - General principles of presentation. Basic conventions for lines.
- ISO 128-22 **Technical drawings** – General principles of presentation - Part 22. Basic conventions and applications for leader lines and reference lines.
- ISO 128-30 **Technical drawings** — General principles of presentation — Part 30: Basic conventions for views.
- EN ISO 3098-0 **Technical product documentation** —Lettering.
- EN ISO 10209-2 **Technical product documentation** — Vocabulary — Part 2: Terms relating to projection methods

The standard DIN ISO 2768-1 define general tolerances for length dimension

Tolerance class		Limit deviations for nominal dimension ranges mm			
Symbol	Name	over 0,5[1)] incl. 3	over 3 incl. 6	over 6 incl. 30	over 30 incl. 120
f	fine	±0,05	±0,05	±0,1	±0,15
m	medium	±0,1	±0,1	±0,2	±0,3
c	coarse	±0,2	±0,3	±0,5	±0,8
v	very coarse	–	±0,5	±1	±1,5
Symbol	Name	over 120 incl. 400	over 400 incl. 1000	over 1000 incl. 2000	over 2000 incl. 4000
f	fine	±0,2	±0,3	±0,5	–
m	medium	±0,5	±0,8	±1,2	±2
c	coarse	±1,2	±2	±3	±4
v	very coarse	±2,5	±4	±6	±8

The standard DIN ISO 2768-1 define general tolerances for angular dimension

Tolerance class		Limit deviations for length ranges of the shorter angular leg mm				
Symbol	Name	incl. 10	over 10 incl. 50	over 50 incl. 120	over 120 incl. 400	over 400
f	fine	±1°	±30′	±20′	±10′	±5′
m	medium					
c	coarse	±1° 30′	±1°	±30′	±15′	±10′
v	very coarse	±3°	±2°	±1°	±30′	±20′

The standard DIN ISO 2768-1 the tolerance classes for broken edges

Tolerance class		Limit deviations for nominal dimension ranges mm		
Symbol	Name	over 0,5[1)] incl. 3	over 3 incl. 6	over 6
f	fine	±0,2	±0,5	±1
m	medium			
c	coarse	±0,4	±1	±2
v	very coarse			

The standard DIN ISO 2768-2 defines general tolerances for geometry and position

Straightness and flatness

Tolerance class	General tolerances for straightness and flatness for nominal dimension ranges mm					
	incl. 10	over 10 incl. 30	over 30 incl. 100	over 100 incl. 300	over 300 incl. 1000	over 1000 incl. 3000
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

The standard DIN ISO 2768-2 defines general tolerances for geometry and position

Perpendicularity

Tolerance class	Perpendicularity tolerances for nominal dimension ranges of the shorter angular leg mm			
	incl. 100	over 100 incl. 300	over 300 incl. 1000	over 1000 incl. 3000
H	0,2	0,3	0,4	0,5
K	0,4	0,6	0,8	1
L	0,6	1	1,5	2

The standard DIN ISO 2768-2 defines general tolerances for geometry and position

Symmetry

Tolerance class	Symmetry tolerances for nominal dimension ranges mm			
	incl. 100	over 100 incl. 300	over 300 incl. 1000	over 1000 incl. 3000
H	0,5	0,5	0,5	0,5
K	0,6	0,6	0,8	1
L	0,6	1	1,5	2

The standard DIN ISO 2768-2 defines general tolerances for geometry and position

Runout

Tolerance class	Runout tolerances mm
H	0,1
K	0,2
L	0,5

Dependence of surface roughness on the Fundamental tolerance grade and nominal dimension

Nominal dimension range [mm]		Fundamental tolerance grade							
		IT 5	IT6	IT7	IT8	IT9	IT10	IT11	IT12
over	inc.	Surface roughness R_a [µm]							
1	3	0,2							
3	6		0,4						
6	10								
10	18								
18	30		0,8						
30	50			1,6			6,3		
50	80				3,2				
80	120							12,5	
120	180								
180	250								25
250	315								
315	400								
400	500								50

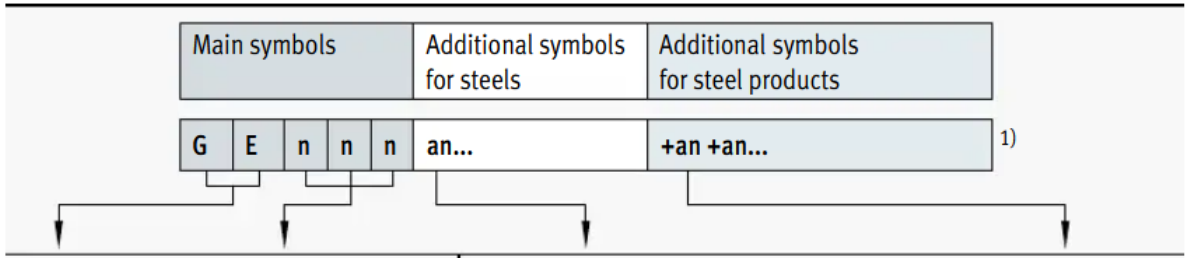
Surface roughness by achieved according fundamental tolerance grade and machining method

Method of machining	Fundamental tolerance grade								
	4	5	6	7	8	9	10	11	12
Lapping	0,05	0,1							
Honing	0,05	0,1							
Centreless grinding and centring grinding		(0,2)	0,4	0,4	0,4	0,8			
Hole grinding			(0,4)	0,4	0,4				
Flat gringing, peripheral grinding		(0,2)	0,4	0,4	0,8				
Surface frontal grinding, cross grinding			(0,2)	0,4	0,4	0,8			
Drilling with diamond tool		(0,2)	0,4	0,4					
Boring			(0,8)	1,6	1,6	3,2			
Broaching			(0,4)	0,8	0,8	1,6			
Reaming				(0,8)	0,8	1,6		3,2	
Turning				(0,8)	(1,6)	1,6	3,2	3,2	6,3
Milling with face and cylindrical cutter					(1,6)	(3,2)	3,2	3,2	6,3
Slot milling					(1,6)	3,2	6,3	12,5	
Planning					3,2	3,2	6,3	6,3	12,5
Predrilling							(6,3)	12,5	
Drilling in jig							(6,3)	12,5	12,5
Values in brackets are available under special conditions									

Steel grades

- unalloyed structural steel,
- quenched and tempered steel,
- case hardening steels,
- stainless steels,
- roling bearing steels,
- free-cutting steels,

System of material designations The standard DIN EN 10027-1:2005 gives short names for steels. The whole standard is very extensive. For this reason, the system of engineering steels is presented as an example.



Main symbols		Additional symbols		
Letter	Mechanical properties	For steel		For steel products
		Group 1	Group 2	
G = Cast steel (if necessary) E = Engineering steels	nnn = Defined yield strength[2] in MPa[3] for the smallest thickness value	G = Other features, if necessary with one or two consecutive numbers or if notched bar impact properties are defined, in accordance with the following rules according to table Notched bar impact work, Page 271	C = Suitability for cold drawing	Symbols for the treated condition: see standard DIN EN 10027-1:2005, Table 18

1) n = number, a = letter, an = alphanumeric.

2) The term "yield strength" is defined, in accordance with the information in the relevant product standard, as the upper or lower yield strength (R_{eH} or R_{eL}) or the proof stress under non-proportional elongation (R_p) or proof stresss under complete elongation (R_t).

3) $1\,MPa = 1\,N/mm^2$.

Mechanical properties The following table gives the mechanical properties of a number of unalloyed structural steels as an extract from the corresponding standard.

Steel grade designation		Tensile strength R_m [1] for nominal thickness values mm			Yield strength R_{eH} [1] for nominal thickness values mm					
Short name [2]	Material number [3]	< 3	> 3 ≦ 100	> 100 ≦ 150	≦ 16	> 16 ≦ 40	> 40 ≦ 63	> 63 ≦ 80	> 80 ≦ 100	> 100 ≦ 150
		N/mm²			min. N/mm²					
S185 [4]	1.0035	310 ... 540	290 ... 510	–	185	175	–	–	–	–
S235JR [4]	1.0037	360 ... 510	340 ... 470	–	235	225	–	–	–	–
S235JRG [4]	1.0036									
S235JRG2	1.0038			340 ... 470	235	225	215	215	215	195
S235J2G3	1.0116									
S275JR	1.0044	430 ... 580	410 ... 560	400 ... 540	275	265	255	245	235	225
S275J2G3	1.0144									
S355J2G3	1.0570	510 ... 680	490 ... 630	470 ... 630	355	345	335	325	315	295
E295 [5]	1.0050	490 ... 660	470 ... 610	450 ... 610	295	285	275	265	255	245
E335 [5]	1.0060	590 ... 770	570 ... 710	550 ... 710	335	325	315	305	295	275
E360 [5]	1.0070	690 ... 900	670 ... 830	650 ... 830	360	355	345	335	325	305

For further mechanical and technological properties and information on the chemical composition of steels see DIN EN 10025 (March 1994).

A list of frequently used steels

Designation of steels according to EN 10025	Designation of steels according to ČSN	Mechanical properties			Characteristics, use and properties
		R_e * [MPa]	R_m * [MPa]	A_5 * [%]	
11SMn30	11 109	195	360-500	21	Free-cutting steel. The steel is very machinable and the surface roughness after machining is good. Hot rolled products are used only for cold drawing or in screw mills to produce fasteners.
DC 01	11 321	235	284-382	-	Plain carbon steel, high-quality, suitable for cold forming, medium drawing, varnishing, melt plating, printing and enamelling - only for uncontaminated steel. Weldability guaranteed depending on the dimensions of the workpiece.
S 235 JRG 1	11 343	196	333-412	30	Low quality steel. Suitable for parts of structures and machines of smaller thicknesses, fused welded statically, resp. even slightly dynamically. Small pressed products such as buckles, building and furniture fittings, holders, rulers, blinds, etc. Various wrought and welded parts, inserts, stirrups, spacers, cotters, eyes, levers, handles, pins, bolts, holders, etc. Tubes for general purposes. Suitable for welding.
S 235 JRG 1	11 373	206	363-441	25	Low quality steel. Usual quality suitable for welding. Components of structures and machines of smaller thicknesses, also fused-welded, statically and slightly dynamically stressed. Water turbine inflow objects, outlets, gate panels, sluices, less stressed welded pipes and couplings, weir structures. Flat, arched and lined bottoms, high pressure. Suitable for welding.
S 235 JRG 2	11 375	226	363-441	25	Low quality steel. Usual quality suitable for welding. Components of structures and machines of medium thickness, welded, stressed statically and dynamically. Components made of sheet metal, longitudinally welded hollow sections and components forged for thermal power equipment and pressure vessels operating with limited overpressure and temperature up to 300 ° C. Water turbine inflow objects, water turbine spiral boxes, vessel gates, shutter flaps, welded ball valves, etc. Wagon couplings and bogies.
S 235 J2G3	11 378	235	363-441	25	Plain carbon steel, high-quality, fine-grained, structural. For thin sheets suitable for pressing. For welded bridge and crane structures, machine parts, thermal power plant components and pressure vessels with limited overpressure up to 300 ° C. Weldability guaranteed.

P265GH	11 416	255	400-490	26	Low quality steel. Low carbon steel, unalloyed steel, for higher temperatures and heat resistant. For components of boilers and pressure vessels. Weldability guaranteed.
E 295	11 500	265	490-608	20	Low-quality steel. Usual quality with higher carbon content. Partially compactable steel suitable for statically and dynamically stressed machine parts where no weldability is required, such as shafts, gears, turned machine parts, pins, pins, holders, washers, covers, caps, flanges, bushings, rings, sleeves, baseplates , guides, clamping plates, clamps, screws, nuts, mounting levers, yokes, pulleys, drums, necks, connections, etc. Metal parts of thermal energy equipment. Less stressed unhardened gears. Weldability difficult.
P355NL1	11 503	345	490-610	26	Plain carbon steel construction fine grain steel for reduced atmospheric temperatures below -20 ° C suitable for welding. Components of equipment operating at temperatures of +400 ° C to -50 ° C made of sheet metal with a guaranteed impact test value up to -50 ° C.
S 355J2G3	11 523	333	510-628	22	Plain carbon steel construction fine-grained quality steel suitable for welding. Bridge and other welded structures, bent profiles, welded structures of hollow profiles and components of machines, cars, motorcycles and bicycles. Parts of thermal power equipment and parts of pressure vessels made of bars.
E 335	11 600	324	588-706	14	Low-quality steel of usual quality with higher carbon content. Suitable for machine parts subjected to static and dynamic stresses, where no weldability is required. Components subject to high specific pressure. Shafts, axles, gears, sprockets, levers, pins, piston rods, pins, supports, handles, sleeves, bolts and nuts, wedges, springs, slide blocks, toothed racks, pulleys, couplings, axial bearing segments and inserts, spacer rings , various clamping elements, cutter bodies, etc. Bands and strips for bending.
E 360	11 700	353	686-834	10	Low-quality steel of usual quality with higher carbon content. Suitable for machine parts with higher resistance to wear and wear resistance, where no weldability is required. Forgings and stampings with high hardness, without heat treatment. Cold rolled strips for plates of Gall chains. Turning tool holders.

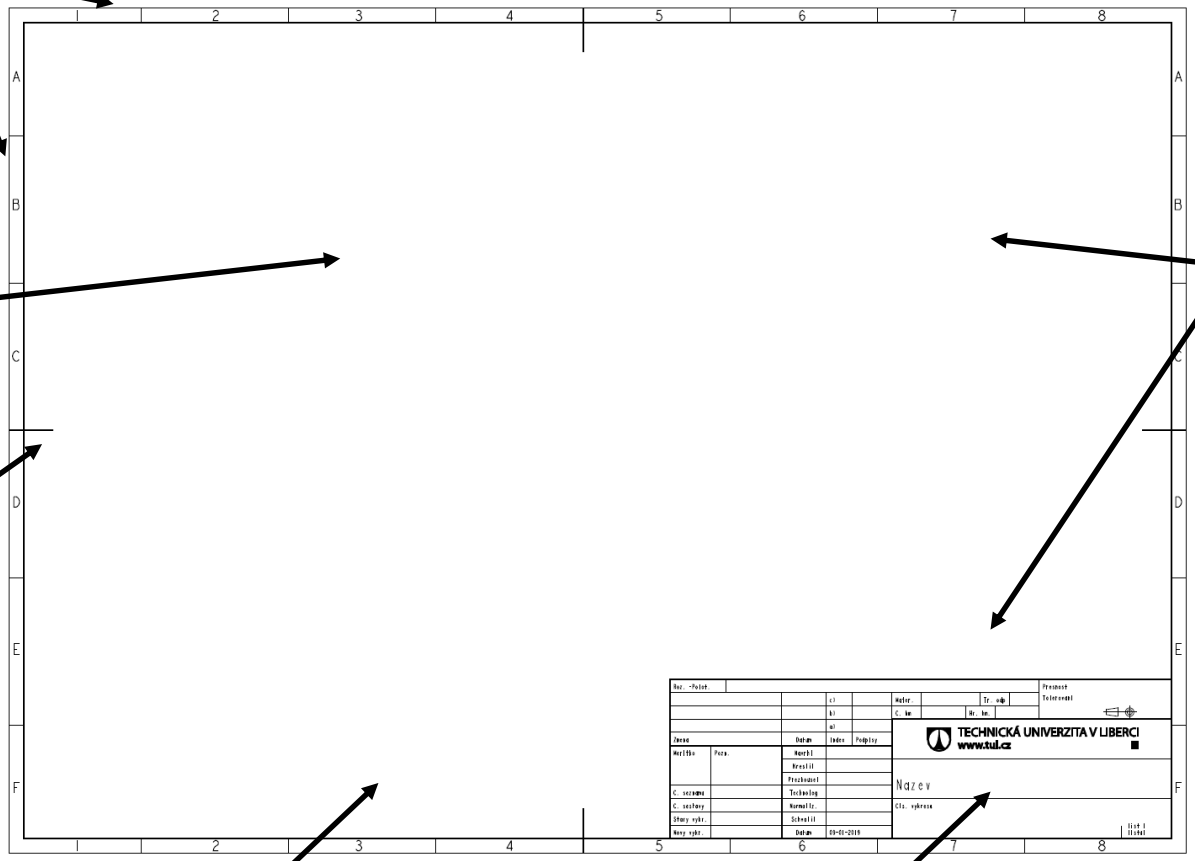
C 45	12 050	510	650-970	17	Structural steel, plain carbon steel for heat treatment, surface hardening and forging. Calm steel suitable for shafts of mining machines, turbocompressors, carousels, etc., for larger gears, worms, gear rings, screw compressor rotors, connecting rods, piston rods, spindles, press plungers, compressor pistons, pins, screws, set screws, conveyor rollers, guide pins, clutch plates, followers, beds, levers, stops, pins, various fasteners, sliding forks, holders, satellite carriers, rocker arms, pawls, forged bolts of pressure vessels, clamping and modular parts of tools, drilling bars, milling arbors. Weldability difficult.
C 55	12 060	345	min. 600	13	Structural steel, plain carbon steel, high-quality for refining. Calm steel suitable for turbocharger shafts, carousels, crankshafts and other shafts, gears and rings, press plungers, piston rods, spindles, pins, slats, couplings, fuses, latches, brackets, screws, levers, abnormal chain plates, various fasteners, etc. Springs, structural elements of pressing tools. For less stressed shafts of road vehicles. For machine parts intended to resist wear (gear rings, drill spindles). Weldability difficult.
C 60	12 061	380	min. 660	12	Structural steel, plain carbon steel, high-quality for refining. Calm steel suitable for crankshaft and eccentric shafts, axes, gears and pinions, pins, plugs, bolts and nuts, lathe spindles, rolling mill cylinders, press plungers, draw hooks, lead screws, levers, bushings, retaining rings, latches, pins, pressure rings, support plates, supports, stops, friction rings, brake keys, fixed and movable parts of cable cars, guide stones, pressure pulleys, wedges and springs, brake housings, carousel lamellas, machetes, friction rings, hardened screws and nuts , flanges of joint chains, etc. springs. Finishing components. Clamping and modular parts of tools. Weldability difficult.
107CrV3	19 421.3	-	-	-	Cr-V steel, low-alloy steel, tool for cold working. Good toughness, more difficult hot formability, good machinability. Cutting tools: drills, reamers, taps for lower cutting speeds. Tools for cold cutting: simple tools for punching materials of smaller thicknesses, auxiliary parts of tools and forms for cold cutting (ejectors, pins, etc.). Forming tools: simple and large drawing tools, large dies. Hand tools: threaded tools, reamers, countersinks, dental drills. Weldability difficult.

Searching technical standards

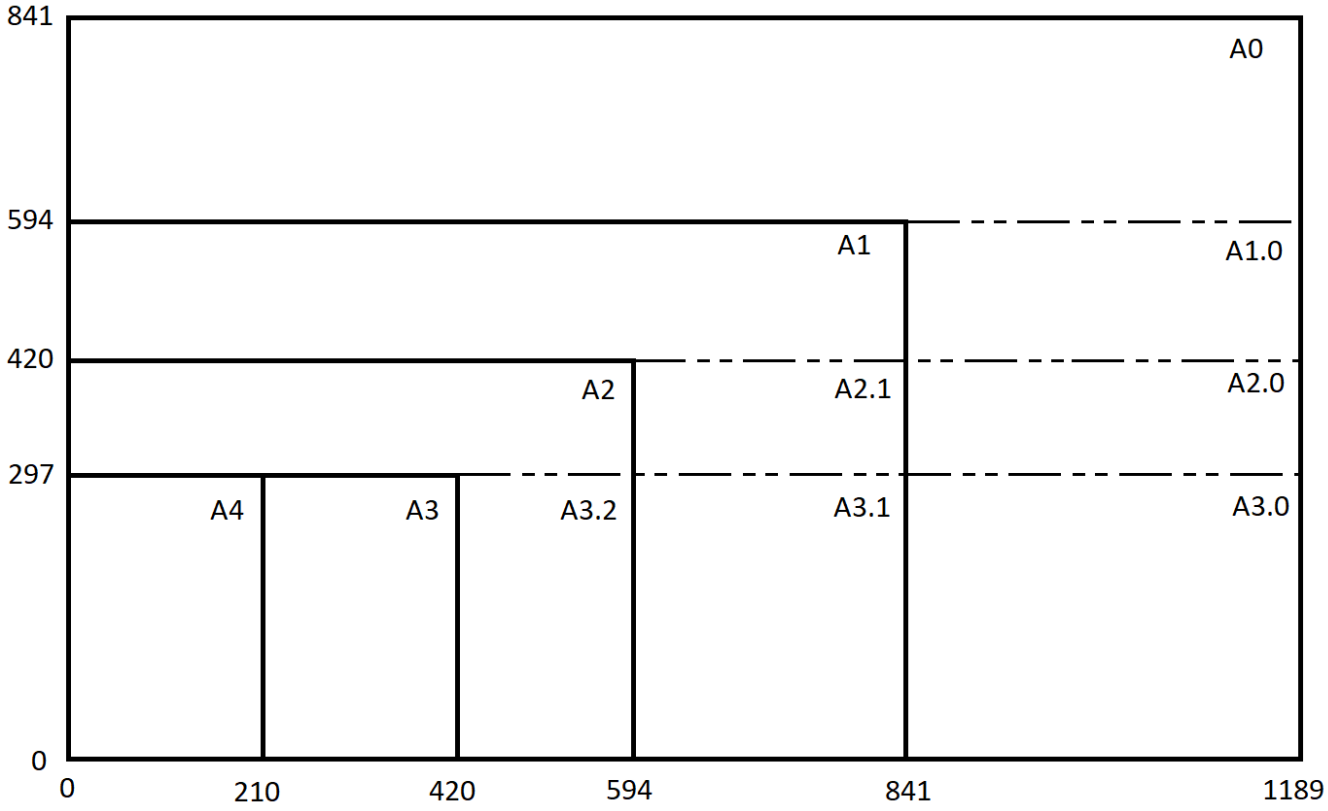
How search technical standards?

Technical standards cannot be useing free of charge. In the Czech Republic it is possible to establish online access to the database of standards, for example through the **Czech Agency for Standardization, European commision**. In companies there is a department of documentation, which usually takes care of obtaining and distributing standards according to the company requirements.

Drawing area

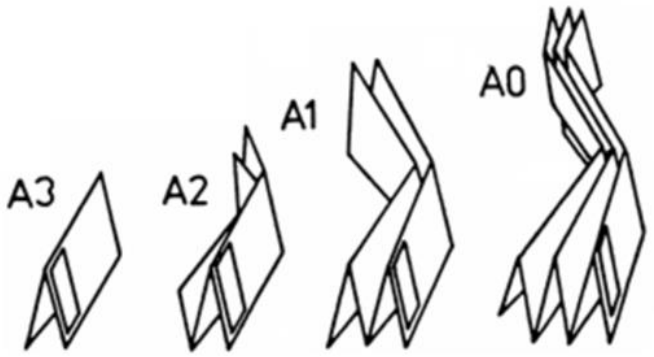


Drawing formats - extended formats
EN ISO 5457



The standard EN ISO 5457 – define sheet sizes

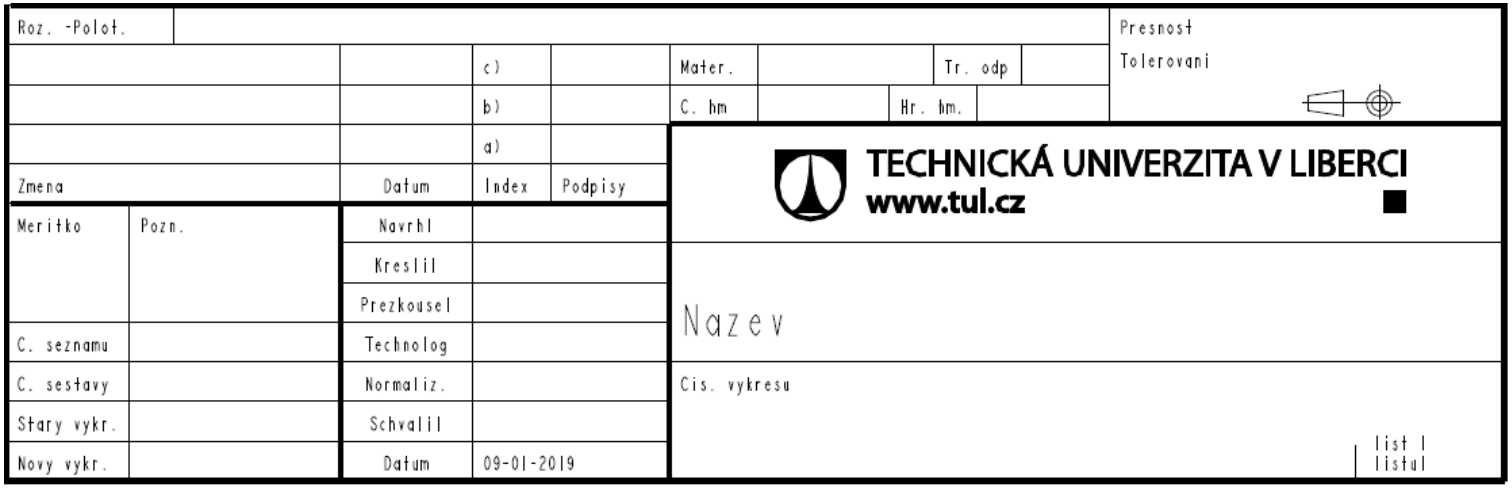
Sheet size[1)]	Trimmed drawing and trimmed blueprint[2)] mm	Drawing area mm	Untrimmed sheet[3)] mm	Usable favourable roller width mm			Base sheet[4)] mm
A0	841×1189	821×1159	880×1230	–	900	–	–
A1	594×841	574×811	625×880	–	900	660	660×900
A2	420×594	400×564	450×25	(2×450)	900	660	450×660
A3	297×420	277×390	330×450	(2×330) (2×450)	660	900	330×450
A4	210×297	180×277	240×330	250	660	–	225×330



Exceptionally extended formats

Number	Value
A0x2	1189x1682
A0x3	~~1189x2523~~
A1x3	841x1783
A1x4	~~841x2378~~
A2x3	594x1261
A2x4	594x1682
A2x5	594x2102
A3x5	420x1486
A3x6	420x1783
A3x7	420x2080
A4x6	297x1261
A4x7	297x1471
A4x8	297x1682
A4x9	297x1892

Title block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Novy vykr.
Datum
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Changes in CAD documentation

INDEX	PLACE	DESCRIPTION	DATUM	SIGNATURE

https://www.systemonline.cz/automotive-it-pro-automobilovy-prumysl/propojeni-erp-systemu-karat-s-pdm-systemem-smarteam-v-modelarne-liaz.htm?mobilelayout=false

Drawing templates

For efficient work, companies create drawing and models templates, where they have predefined all the models and drawing parameters (frame, description field, line weight, font, etc.). This ensures standartized consistent 3D and 2D drawings.

Non-drawing documentation

Currently, only 3D documentation is gaining in importance. Current software already allows to define tolerances, roughness and other information directly in the model (assembly, part). For data management it will clearly be more convenient to manage one data, not 3D and 2D documents. This completely eliminates the mismatch between 2D and 3D documentation.

https://www.cad.cz/pdmplm/86-pdmplm/4632-bezvykresova-dokumentace-nastupujici-realita.html

Conclusion

The drawing documentation together with the 3D model is a source of all information for the production of the product. Precision and accuracy of execution is the basic prerequisite for trouble-free production. It should be emphasized that this documentation is alive throughout the production process and that it is the result of technical cooperation within all stakeholders.

Questions :

- Explain the concept of purity of CAD data.
- Explain DIN ISO 2768-1.
- How we define changes in CAD documentation.

Topic of the next lecture:

„Basic rules of dimenzioning “

Thank You

Used literature and sources of information :

https://www.systemonline.cz/automotive-it-pro-automobilovy-prumysl/propojeni-erp-systemu-karat-s-pdm-systemem-smarteam-v-modelarne-liaz.htm?mobilelayout=false

https://www.cad.cz/pdmplm/86-pdmplm/4632-bezvykresova-dokumentace-nastupujici-realita.html

https://www.scribd.com/document/364394796/Schaeffler-Technical-Pocket-Guide-STT-En