

CHAPTER 7. THE PRINCIPAL RULES OF A DRAWING PRESENTATION

7.1. Unified System of Engineering Papers

The unified rules on presentation of drawings and other technical papers are regulated by Unified System of Engineering Papers (USEP).

The goal of USEP standards is to adopt unified regulations for the completion, presentation and legalisation of engineering papers to achieve the following:

- the opportunity to exchange engineering papers among organisations and productions without their re-presentation;
- the stabilisation of integrity to avoid duplication and the development of unnecessary manufacturing documents;
- the unification of the design of projects for industrial production;
- the simplification of forms of engineering papers and graphical representations;
- the mechanisation and automation of technical papers and information processing;
- the improvement of the operational conditions of industrial products;
- prompt preparation of papers for efficient field re-adjustment.

USEP standards for the development, legalisation and circulation of documents regulate all engineering papers; recording and registering documents; technical specifications and technological documentation; scientific and technical literature and textbooks (unless specially regulated).

USEP standards must be assumed to be the foundation of different methodical and manufacturing papers and technical instructions.

Any object or set of objects produced at a manufacturing plant is referred to as a **product**. Products are classified as parts (details), assembly units, complexes and sets.

A *Detail* is a product manufactured without assembly operations from a specific homogeneous material (e.g. a drill, a bolt, a nut, etc.).

Parts of a detail having a certain destination are called its *elements*, e.g. a chamfer, groove, fillet, etc.

An *Assembly unit* is a product the parts of which are to be joined by mounting operations, e.g. a machine, telephone, etc.

Complex - two or more products (consisting of two or more parts each) not assembled by the manufacturer but designated to fulfil interrelated operational functions, e.g. shop-automaton, drilling rig, etc.

Set - two or more products not assembled by the manufacturer, being a collection of auxiliary items for an operation, e.g. a set of spare parts, etc.

Engineering papers are the graphical and text documents specifying (separately or as a set) the construction of a product, and including all necessary data for its manufacture, control, operation and repair.

There are 25 types of engineering papers settled by standards in accordance with the contents. Among them: the drawing of a detail, outline drawing, assembly drawing, specifications and others.

The Drawing of a detail is a document containing a detail representation and other data necessary for its manufacture and control.

An Assembly drawing is a document containing an assembly unit's representation and other data necessary for its assembly (manufacture) and control.

An Outline drawing is a document specifying the design of a product and the interactions of its parts, and clarifying the principles of the product's functioning.

A *Specification* is a document specifying the composition of an assembly unit, a complex or a set.

7.2. Formats and Title Blocks

Format (from Latin "*forma*" - looks, appearance) - the size of drawing sheets and other engineering papers. The regulations establish the following formats and their designations:

Format designation	A0	A1	A2	A3	A4
Dimensions of a format, mm	841 × 1189	594 × 841	420 × 594	297 × 420	210 × 297

If it is necessary it is permitted to use size A5, 148 mm x 210 mm.

The square of size A0 is 1m^2 , the ratio of sides is $1: \sqrt{2}$. Solving of the above two equations determines the dimensions of a format's sides. Each next smaller format is obtained by division (parallel to its smaller side) of the previous format into halves.

It is permissible to use auxiliary formats, produced by means of enlarging the short sides of the basic formats by multiplying by an integral number. For example: size A0 x 2 is 1189 x 1682, size A4 x 3 is 297 x 630, etc.

The format of paper sheets corresponds to the dimensions of the drawing external frame passed with a thin line (the line of clipping a drawing after its completion). The frame of drawing is produced with the base-line. The distance between the edge of paper and the frame is 5 mm and more space is on the left side (20 mm). A specimen lay out (with title blocks, 185 x 55, and an additional box, 70 x 14) is shown in Fig.7.1.

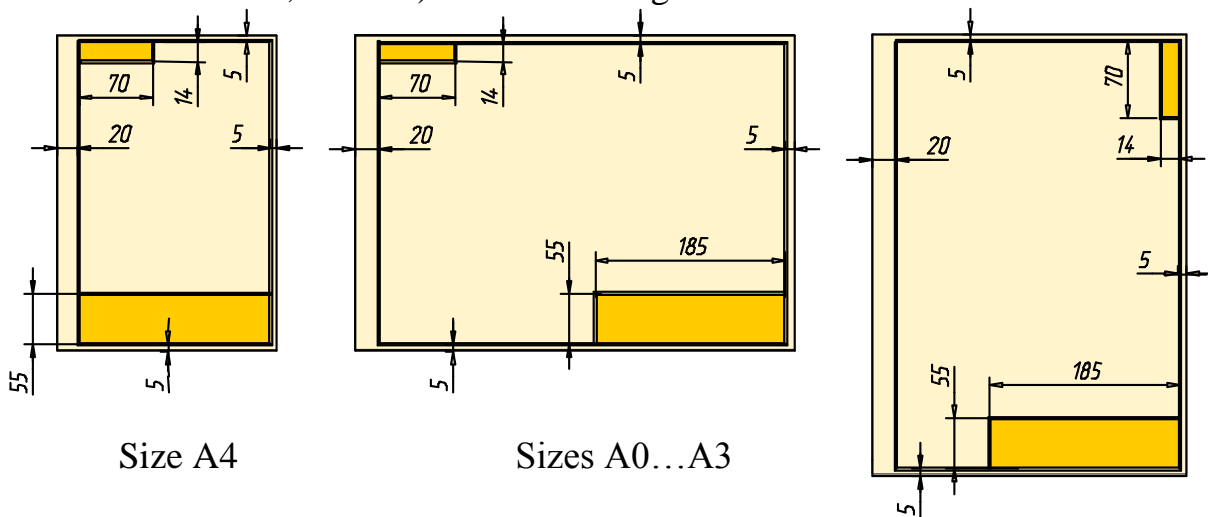


Fig.7.1

For size A4 the title blocks (or boxes) are spread out along the bottom of the paper. For the other sizes - in the lower right-hand corner close to the frame.

Position an additional box in the upper left-hand corner of size A4, and spread it out at the top along the longer side of other formats (Fig.7.1).

The title blocks are drawn in base and thin lines (Fig.7.2). The information in the title blocks is arranged in the following way:

- Box 1 – Name of item (of your task) Lettering №7,
- Box 2 – Drawing Designation (Lettering №7)

DGG I. XXXXXX. 001
a b c d

- a – Department of Descriptive Geometry and Graphics;
- b – Test number;
- c – Classification characteristics of the item (for a detail or an assembly unit drawing) or XXXXXX (for other drawings);
- d – The last figure of the student’s card number;
- Box 3 – Material of the item;
- Box 4 – “T” (training drawing);
- Box 6 – Scale (is not denoted on a sketch)

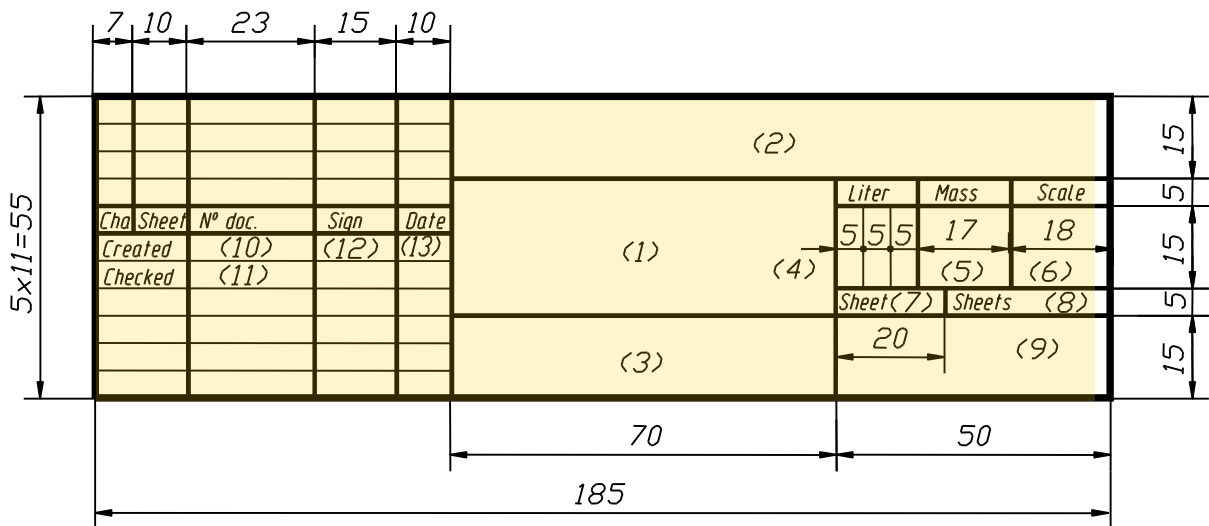


Fig.7.2 Title Blocks (Form 1)

- Box 7 – Sheet number (if the task consists of one sheet, the box is not filled in)
- Box 8 – Total number of sheets in the test (is filled in only on the first sheet of the test)
- Box 9 – TPU (Tomsk Polytechnic University), CDL (Center of Distance Learning), Group number
- Box 10 – Student’s Name
- Box 12 – Student’s Signature
- Box 13 – Date
- Other boxes are not filled in for training drawings.

A drawing designation turned by the angle of 180° is inserted in an additional box for size A4, and the larger formats if the title blocks spread out along the longer side of a sheet. If in these formats the title blocks are spread along the shorter side, a drawing designation should be turned by the angle of 90°.

7.3. Scales

Scale is a ratio of a representation's dimensions to the natural dimensions of a product.

According to the drawing's complexity and the dimensions of the items being represented, select the scales from the following table:

Reduction scales	1:2; 1:2.5; 1:4; 1:5; 1:10; 1:15; 1:20; 1:25; 1:40; 1:50; 1:75; 1:100, etc.
Nominal scale	1:1
Increase scales	2:1; 2.5:1; 4:1; 5:1; 10:1; 20:1; 40:1; 50:1; 100:1; etc.

Choose a scale to make working with a drawing easier.

The Scale is inserted in the box "Scale" of the title blocks. When dimensioning a drawing, the scale different from that printed in the title blocks, is placed just above the representation near the representation sign.

Example: for extension elements, auxiliary and detail views - A(2:1)
for sectional views and sections - A-A(2:1)

7.4. Lines

The Regulations establish design and principle applications of lines on drawings for all production and construction industries.

Thickness s of a continuous base-line must be 0.5 - 1.4 mm, depending on the size and complexity of the representation and on the drawing size (format). The lines of one drawing must be of equal thickness on all elevations drawn to one scale. You are recommended to draw continuous base-lines 0.8 - 1 mm thick.

The standard establishes the minimal thickness of lines and the minimal distance between adjacent lines depending on a drawing size; it also specifies the outlining of representations:

- * the length of dashes of dashed and dash-and-dot lines depends on the dimensions of representations;
- * dashes should be approximately equal in length;
- * spaces between dashes of each line must be approximately equal;

- dash-and-dot lines must intersect and end in dashes;
- * dash-and-dot lines applied as centre lines should be replaced by continuous thin lines, if a circle diameter or dimensions of other geometric figures on representation is less than 12 mm;
- for complex sectional views and sections it is permitted to connect the ends of a broken line by a thin chain line.

The Lines and Their Applications


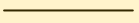







Item	Outline	Thickness	Principal Applications
1. Continuous thick base-line		s	Visible outlines; visible transition lines; outline of section (removed and detail)
2. Continuous thin		From s/3 to s/2	Outlines of covering (revolved) section; dimension and extension lines and their shelves; hatching; outlines of adjacent parts; limit lines; imaginary, fictitious lines; traces of planes
3. Continuous irregular (wavy)		From s/3 to s/2	Break lines; separating lines between a view and a sectional view
4. Short dashes (dashed line)		From s/3 to s/2	Hidden outlines, invisible transition lines
5. Chain (dash-and-dot line)		From s/3 to s/2	Axis and centre lines; section lines being symmetry axes for removed and covering sections
6. Chain thick		From s/2 to 2/3s	Indication of surfaces which have to meet special requirements; lines of elements located in front of a cutting plane ("covering projection")
7. Broken		From s to 1.5s	Section lines
8. Continuous polygonal thin		From s/3 to s/2	Long lines of a break
9. Double-dotted chain		From s/3 to s/2	Bend lines of developments; lines of parts of products in utmost or intermediate positions; lines representing a development coincided with a view

Fig.7.3 presents the dimensions recommended for some types of lines: dashed, chain, chain thick and double-dotted chain.

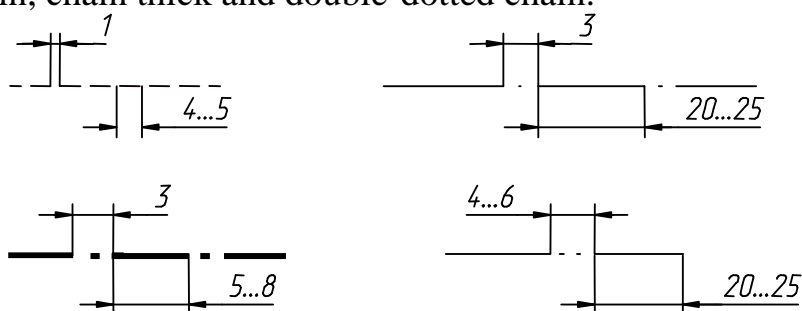


Fig.7.3

7.5. Lettering

All notes on drawings and other technical papers are completed by the drawing lettering. The lettering for technical papers of all production and construction fields is regulated by a standard.

The principal lettering parameters (Fig.7.4):

lettering size h – height of capital letters in mm, measured along a line perpendicular to the basis of line;

height of small letters c (without branches - k);

width of a letter g – maximal width of a letter;

thickness of a lettering line d depends on type and height of lettering.

There are the following *lettering types*:

type A without sloping ($d=1/14h$); type A with sloping of about 75° ($d=1/14h$); type A with sloping of about 75° ($d=1/10h$);

type B without sloping ($d=1/10h$);

type B with sloping of about 75° ($d=1/10h$), with the parameters shown in the table.

The following lettering sizes are specified by the standard:

(1.8); 2.5; 3.5; 5; 7; 10; 14; 20; 28; 40

Lettering of Type B

Parameter	Des-n	Relative size		Dimensions, mm				
Lettering size	h	$(10/10)h$	$10d$	2.5	3.5	5.0	7.0	10
Height of capital letters	c	$(7/10)h$	$7d$	1.8	2.5	3.5	5.0	7.0
Distance between letters	a	$(2/10)h$	$2d$	0.5	0.7	1.0	1.4	2.0
Minimal pace of lines	b	$(17/10)h$	$17d$	4.3	6.0	8.5	12	17
Minimal space between words	e	$(6/10)h$	$6d$	1.5	2.1	3.0	4.2	6.0
Thickness of lettering lines	d	$(1/10)h$	d	.3	.4	0.5	0.7	1.0

Notes: 1. Distance *a* between the letters the neighbouring lines of which are not parallel to each other (e.g. *TA*, *AT*), may be reduced by a half, i.e. by the thickness *d* of the lettering lines.

2. Minimal distance *e* between the words, separated by punctuation marks, is the distance between a punctuation mark and a word following it.

Width of Letters and Figures

Letters and Figures		Relative size		Lettering dimensions, mm				
				2.5	3.5	5.0	7.0	10
Width of figures and №	<i>1</i>	(3/10)h	3d	0.8	1.1	1.5	2.1	3
	<i>4</i>	(4.5/10)h	4.5d	1.1	1.6	2.3	3.2	4.5
	<i>2,3,5,6,7,8,9,0</i>	(5/10)h	5d	1.3	1.8	2.5	3.5	5
	<i>№</i>	(10/10)h	10d	2.5	3.5	5	7	10
Width of capital letters	<i>Г,Е,З,С</i>	(5/10)h	5d	1.3	1.8	2.5	3.5	5
	<i>Б,В,И,Й,К,Л,Н,О,П</i>	(6/10)h	6d	1.5	2.1	3	4.2	6
	<i>Р,Т,У,Ц,Ч,Ъ,Ь,Э,Я</i>	(6/10)h	6d	1.5	2.1	3	4.2	6
	<i>А,Д,М,Х,Ы,Ю</i>	(7/10)h	7d	1.8	2.5	3.5	4.9	7
	<i>Ж,Ф,Ш,Щ</i>	(8/10)h	8d	2	2.8	4	5.6	8
Width of small letters	<i>с</i>	(4/10)h	4d	1	1.4	2	2.8	4
	<i>з</i>	(4.5/10)h	4.5d	1.1	1.6	2.3	3.2	4.5
	<i>а,б,в,г,д,е,и,к,л,н</i>	(5/10)h	5d	1.3	1.8	2.5	3.5	5
	<i>о,п,р,у,х,ц,ч,ъ,ь,э,я</i>	(5/10)h	5d	1.3	1.8	2.5	3.5	5
	<i>м,ы,ю</i>	(6/10)h	6d	1.5	2.1	3	4.2	6
	<i>ж,т,ф,ш,щ</i>	(7/10)h	7d	1.8	2.5	3.5	4.9	7
Width of capital letters	<i>I</i>	(1/10)h	d	0.3	0.4	0.5	0.7	1.0
	<i>J</i>	(4/10)h	4d	1	1.4	2	2.8	4
	<i>C,E,F,L</i>	(5/10)h	5d	1.3	1.8	2.5	3.5	5
	<i>B,D,G,H,K,N,O</i>	(6/10)h	6d	1.5	2.1	3	4.2	6
	<i>P,Q,R,S,T,U,Z</i>	(6/10)h	6d	1.5	2.1	3	4.2	6
	<i>A,M,V,X,Y</i>	(7/10)h	7d	1.8	2.5	3.5	4.9	7
	<i>W</i>	(9/10)h	9d	2.2	3.1	4.5	6.3	9
Width of small letters	<i>i</i>	(1/10)h	d	0.3	0.4	0.5	0.7	1.0
	<i>l</i>	(2/10)h	2d	0.5	0.7	1.0	1.4	2.0
	<i>j</i>	(3/10)h	3d	0.8	1.1	1.5	2.1	3.0
	<i>c,f,r,t</i>	(4/10)h	4d	1	1.4	2	2.8	4
	<i>a,b,d,e,g,h,k,n</i>	(5/10)h	5d	1.3	1.8	2.5	3.5	5
	<i>o,p,q,s,u,v,x,y,z</i>	(5/10)h	5d	1.3	1.8	2.5	3.5	5
	<i>m,w</i>	(7/10)h	7d	1.8	2.5	3.5	4.9	7

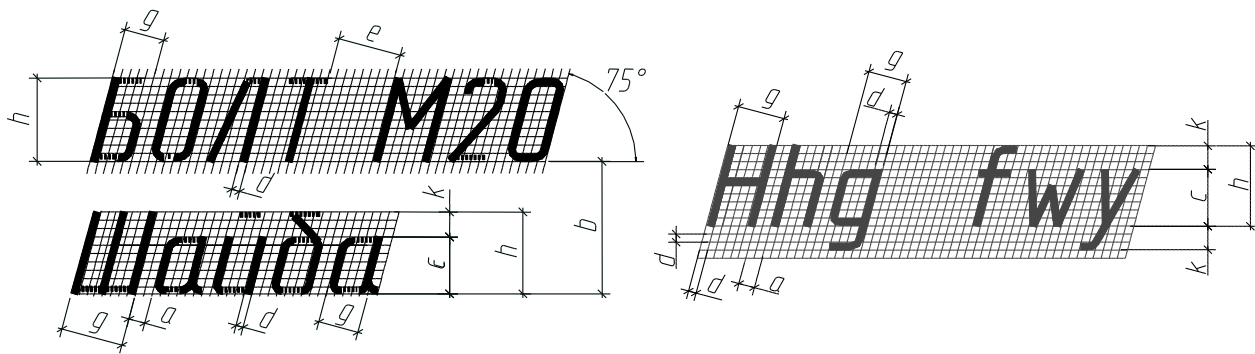


Fig.7.4

АБВГДЕХЗИЙКЛМНОПРСТУ

ФХЦЧШЩЬЫЬЭЮЯ

абвгдежзиклмнопрсту

фхцчшщьюэя

ABCDEFGHIJKLMNOPQRST

UVWXYZ

abcdefghijklmnopqrst

uvwxyz

1234567890 3 N°

Fig.7.5

Standard drawing lettering consists of the Russian, Latin and Greek alphabets, and the Arabian and Roman figures and symbols. A specimen of the Russian and Latin lettering is presented in Fig.7.5.

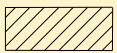

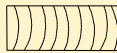


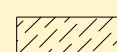
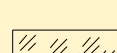

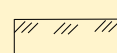
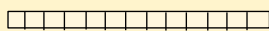
To print notes on drawings, students must know not only the design of letters and figures, but also the most rational sequence of their outlining. As a rule, when outlining letters and figures, it is recommended to draw all vertical and sloping elements downwards, the horizontal ones - rightwards.

An auxiliary gauze, into which the letters are inscribed, may be applied for printing. The pace of auxiliary lines of the gauze depends on the thickness d of the lettering.

7.6. Material Designations

Brands of materials are designated in the engineering papers in accordance with the standards for these materials. They are specified by alphanumeric designations.

Graphical conventions of materials in the sections depend on the type of material from which a detail is manufactured.

Material	Conventions
1. Metals and hard alloys	
2. Non-metallic materials including fibrous, monolith and extruded materials (except named below)	
3. Timber	
4. Natural stone	
5. Ceramic and silicate material for masonry	
6. Concrete	
7. Glass and other light-penetrable materials	
8. Liquid	
9. Natural ground	
10. Gauze	

The distance between the parallel hatching lines is from 1 to 10 mm, depending on the hatched area, and should be similar for all sections of a given part drawn to one scale.

The hatching lines should normally be drawn at 45° to the frame of the drawing sheet. No restrictions for the direction of hatching but it should be similar for one and the same part in all sections of one drawing. If the shape or position of the section would bring 45° sectioning parallel or nearly parallel to the outlines or axis lines, another angle may be chosen (usually it is 30° or 60° to a horizontal side of the frame).

Cross-hatching of adjacent parts is drawn in the opposite directions (one - rightwards, the other – leftwards). When there are three or more adjacent sections, the direction and also space of the hatching are changed (Fig.7.6).

Sections, the width of which on a drawing is less than 2 mm, are represented blackened with the clearances from 0.8 mm between the adjacent sections (Fig.7.7).

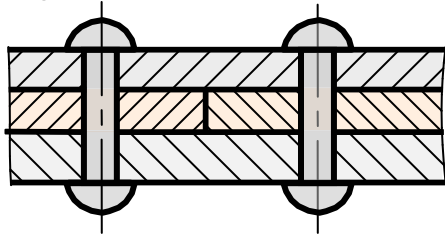


Fig.7.6



Fig.7.7

If a long and narrow section (2-4 mm wide on a drawing) is represented, cross-hatch it only on the ends and at the outline of the holes; the rest section area is presented as shown in Fig.7.8. In such cases, the section lines are inclined at 15° - 20° to the longer side of the section outline.

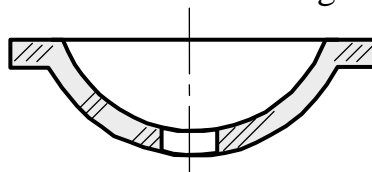


Fig.7.8



Fig.7.9

Questions to Chapter 7

1. What are the dimensions of size A4 of a drawing sheet?
2. What format has the side of 594 mm?
3. What is the application of dash-and-dot line?
4. What is the recommended thickness of section lines?
5. How thick should the broken line be?
6. What are the lettering dimensions according to standards?
7. What value determines the lettering size?
8. How to determine the height of small letters?