Title
LRL TECHNICAL ILLUSTRATOR'S STYLE MANUAL

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DISCLAIMER

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Lawrence Radiation Laboratory
Berkeley, California

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February 1966

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Contents

Appendix (cont.)

LIST OF FIGURES

LRL TECHNICAL ILLUSTRATOR'S STYLE MANUAL

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INTRODUCTION

The following information has been prepared with the needs of the illustrator in mind. Included are samples of standard LRL forms for graphs and engineering drawings, along with information on various common types of three-dimensional drawing projections.

In the Appendix are tables showing editing symbols, chemical symbols, etc.—various bits of information that the illustrator needs.

Although this manual is primarily for use by LRL illustrators, I hope that other LRL employees involved with technical illustrations will find this manual helpful.

The Technical Illustration Section is a part of the Technical Information Division and is directly responsible to it. Technical Information Division is directed by the AEC to review and prepare for publication all articles and reports on work done at the Laboratory under AEC contract.

The technical illustrators have the responsibility of preparing all drawings for UCRL reports and journal papers, as well as for slides used to illustrate talks given by the scientific staff.

Although work for reports and slides has first priority, the illustrators are expected to help other departments solve their artistic problems, but not at the expense of Information Division work. If there is a conflict of work priorities, the main Information Division office will decide the work sequence.

LRL DRAWING STANDARDS

Graphs

Linear Graphs

The basic linear graph has two axes:

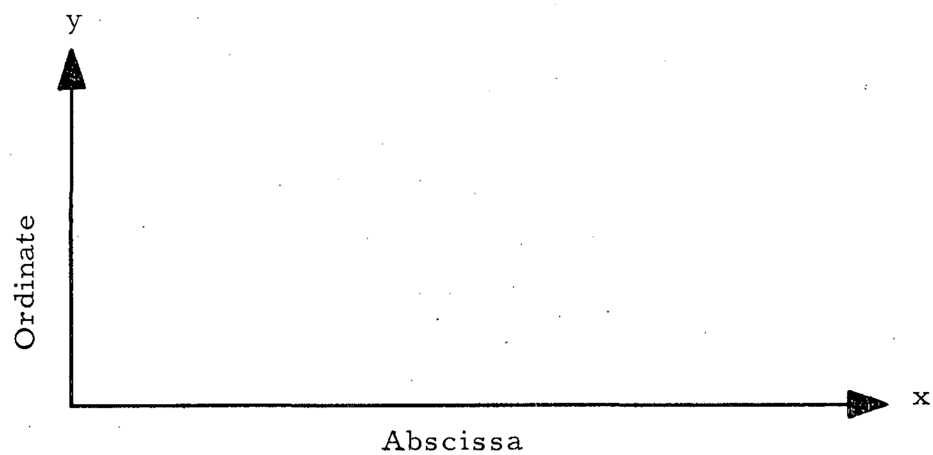

Fig. 1. Sample x, y axis terminology.

A typical linear graph is shown in Fig. 2. The x or abscissa labels and numbers are lettered horizontally. All lettering on the (vertical) y or ordinate axis, other than the numbers, are lettered to be read by turning the paper clockwise 90 deg.

LRL prefers to have report graphs traced onto vellum tracing paper in india ink by means of Leroy lettering guides. The size of lettering used is dependent on how much reduction is involved and can be determined from Fig. 7 on page 11.

The important information should be emphasized by line weights heavier than the border. Short ticks on all four borders at the numbers are essential in order to read the curve intelligently.

The labels on the ordinate and abscissa are lettered in lower case letters with only the first word capitalized. Units of measurement are enclosed in parentheses and abbreviated in accordance with the style manual as listed in Table VI in the Appendix.

Decimal numbers are always preceded by a zero when the quantity is less than one (0.1). When making the decimal be sure it is heavy enough to stand reduction.

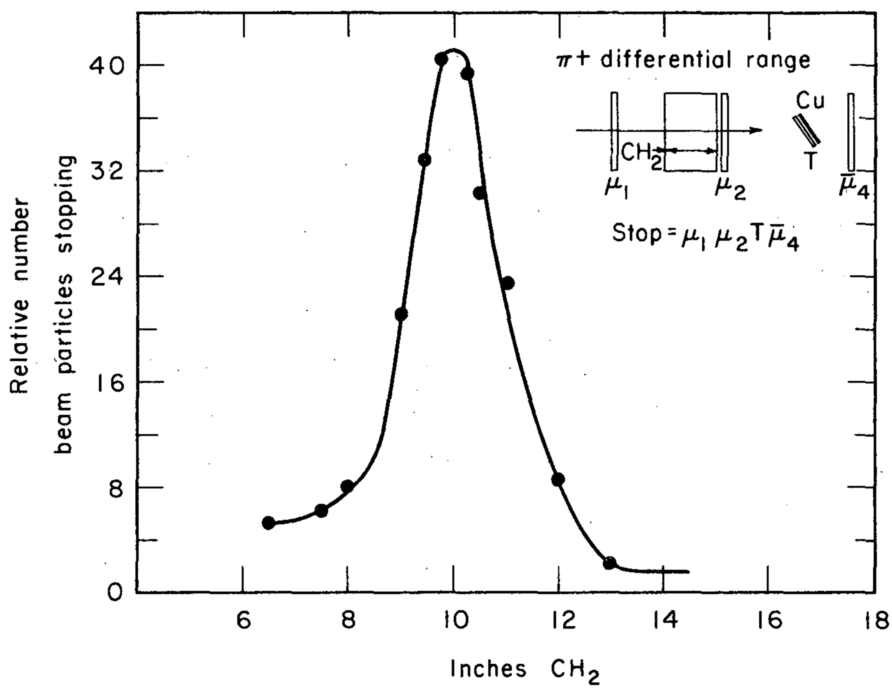

Fig. 2. Linear graph.

Lettering on all drawings should be kept to a minimum. For UCRL reports figure captions are typed by the Information Division scientific report typist and stripped into the Multilith masking sheet after the negative has been made. In some cases titles are put on drawings for slides or for display, but these are exceptions and not the rule.

Most authors want experimental or theoretical points showing on their graphs. The most commonly used symbols in order of preference are:

○, ●, △, ▲, ▽, ▼, □, ■

This combination of open and closed points should take care of most drawings.

Authors sometimes make x' s for points. When reduced, x' s tend to fill in and become indistinct. Standard practice in such cases is to substitute one of the approved symbols.

All points and curves should be traced on vellum with extreme accuracy, otherwise incorrect information can be given. Some points will have flags (error bars) denoting an error spread. In such cases make all points the same size and accurately draw the error flags through the center of the point, as

Items to remember:

1. Be accurate in tracing curves and points.
2. Pick line weights that show the curve to best advantage.
3. Make tick marks approximately 3/16 in. long, unless specifically indicated, on all four sides of the box where numbers are indicated.
4. Make all points the same size.
5. Last, but most important of all, choose large lettering.

Semilogarithmic Graph

This type of graph (see Fig. 3) is used to condense information that otherwise would run too long in one direction to fit on standard-size paper. The difference in making this type of graph is in the ticks on the logarithmic

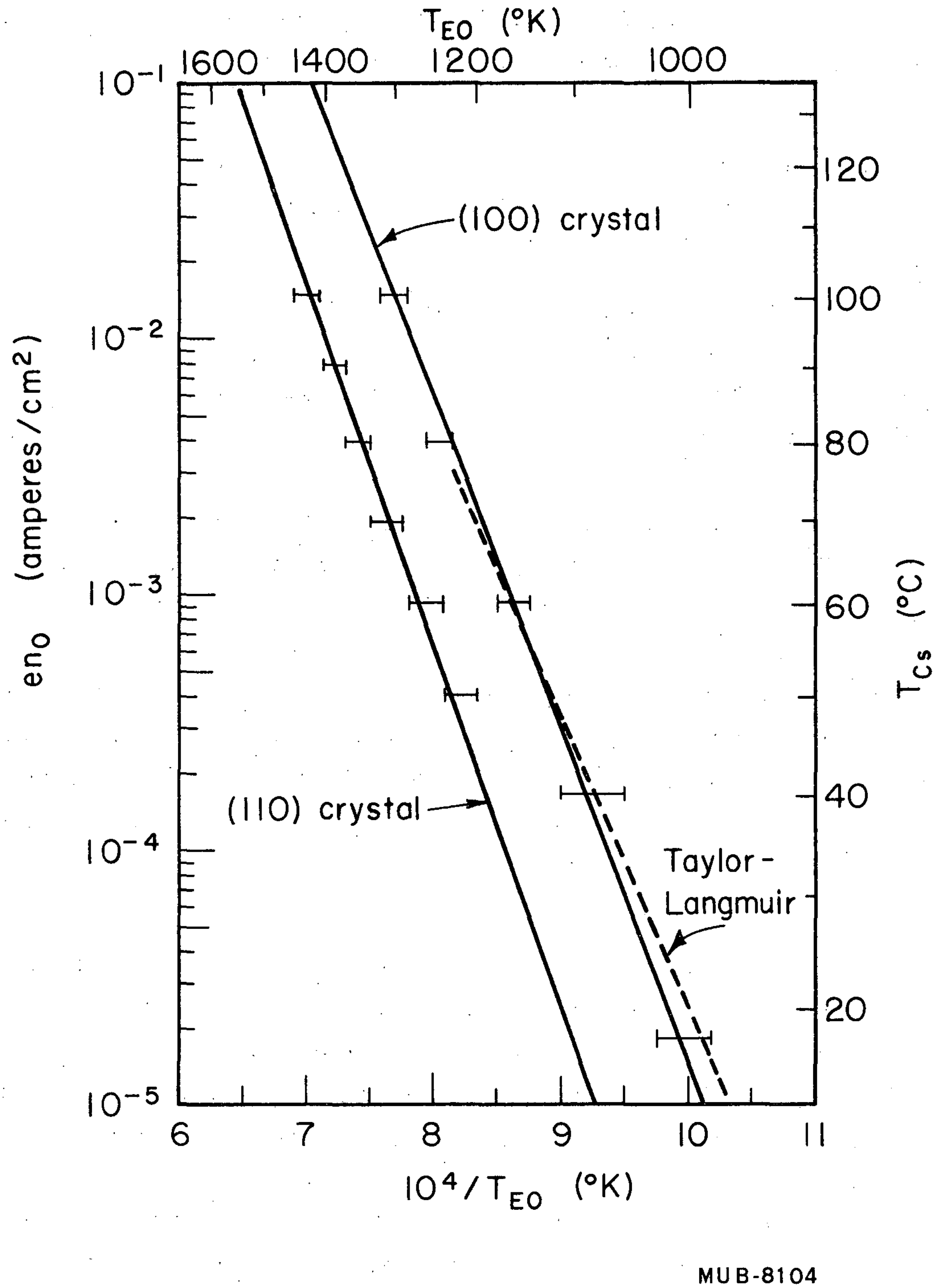

Fig. 3. Semilogarithmic graph.

side. Only the main decades are numbered, but the numbers in between have to be marked with a shorter tick. Make the minor ticks 3/16 in. long, half decade 1/4 in. long and the main decades 1/2 in. long.

Logarithmic Graph

The same holds true for logarithmic graphs as for semilogarithmic graphs, with the exception that the log scale is on both axes (see Fig. 4).

Bar Graph

The bar graph (see Fig. 5) is very effective for comparison purposes where graphic presentation, without much accuracy, is desired. In this type of graph the illustrator is given an opportunity to break away from the established rules. The only criterion is that of showing the information in as clear and graphic a manner as possible.

To show differences within the same bar, use varying patterns of Blu-Zip. This serves to break up large areas which would normally be solid black. The Multilith machines have difficulty inking large dark areas—they tend to overload the ink, making a blurry image.

Blu-Zip patterns give a great variety of patterns and have the added advantage (thanks to a special adhesive) of being able to go through an Ozalid or Bruning print machine without coming off the drawing. With regular Zip-A-Tone, the heat melts the wax adhesive and the Zip comes off the drawing, usually sticking to the light source.

Block Diagrams

Block diagrams are useful for showing how component parts are put together or how they are related (see Fig. 6). They are used where distances are not important, but the order of arrangement is.

The form followed is to make the boxes with a heavy line weight, and connecting lines half the box weight. Spacing and lettering size are up to the illustrator.

Flow charts and organizational charts are forms of block diagrams. In each case the measured distance between the components is of no importance. The order in which they are connected is the idea to be stressed.

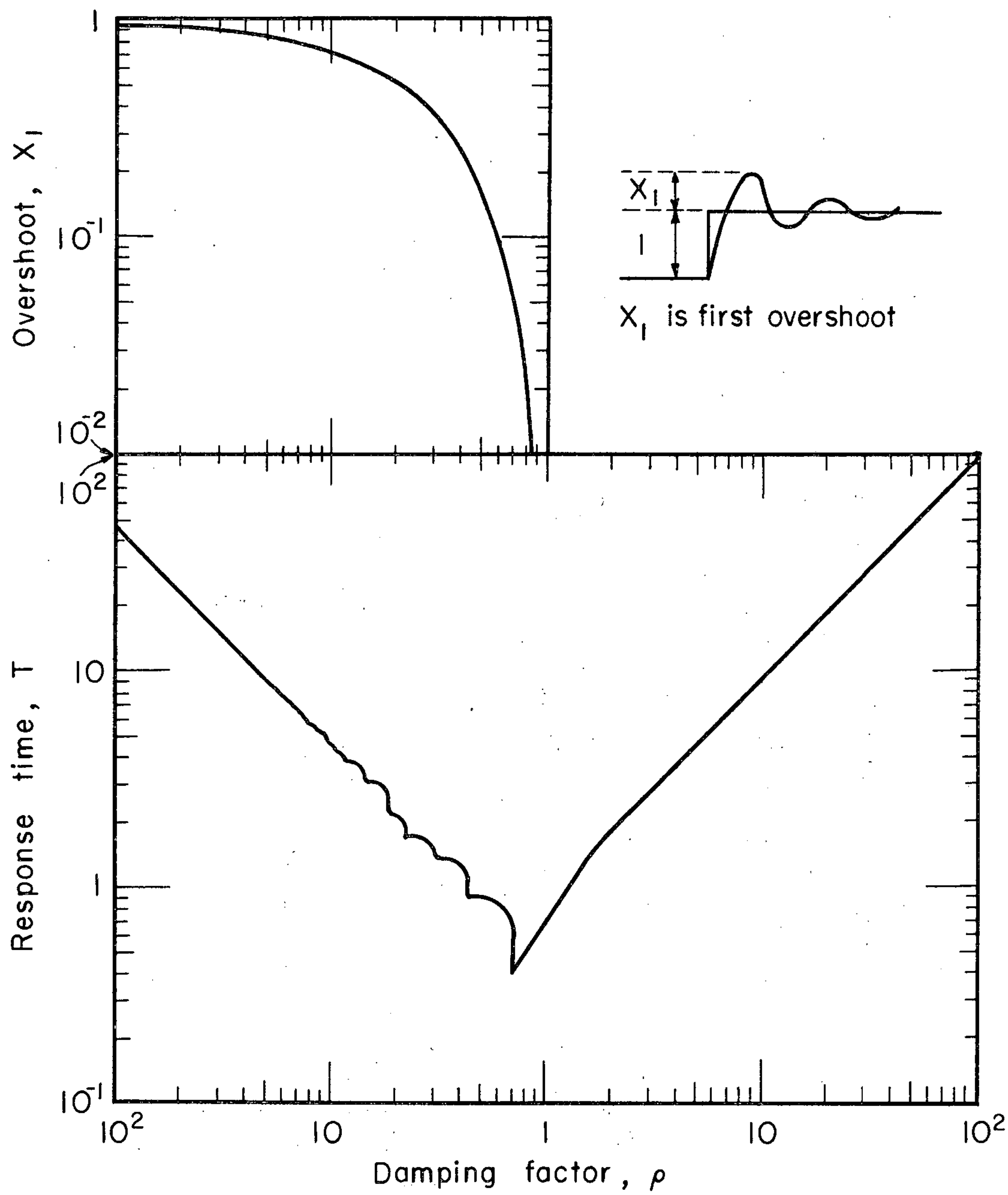

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Fig. 4. Logarithmic graph.

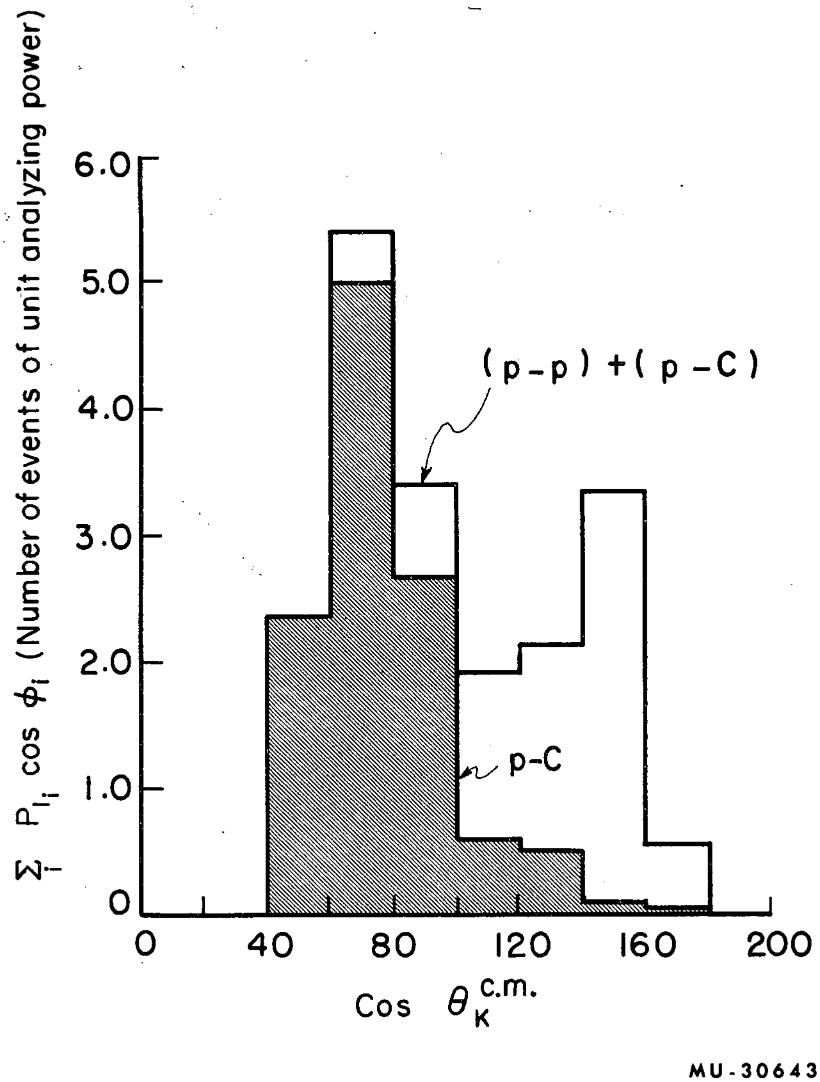

Fig. 5. Bar graph.

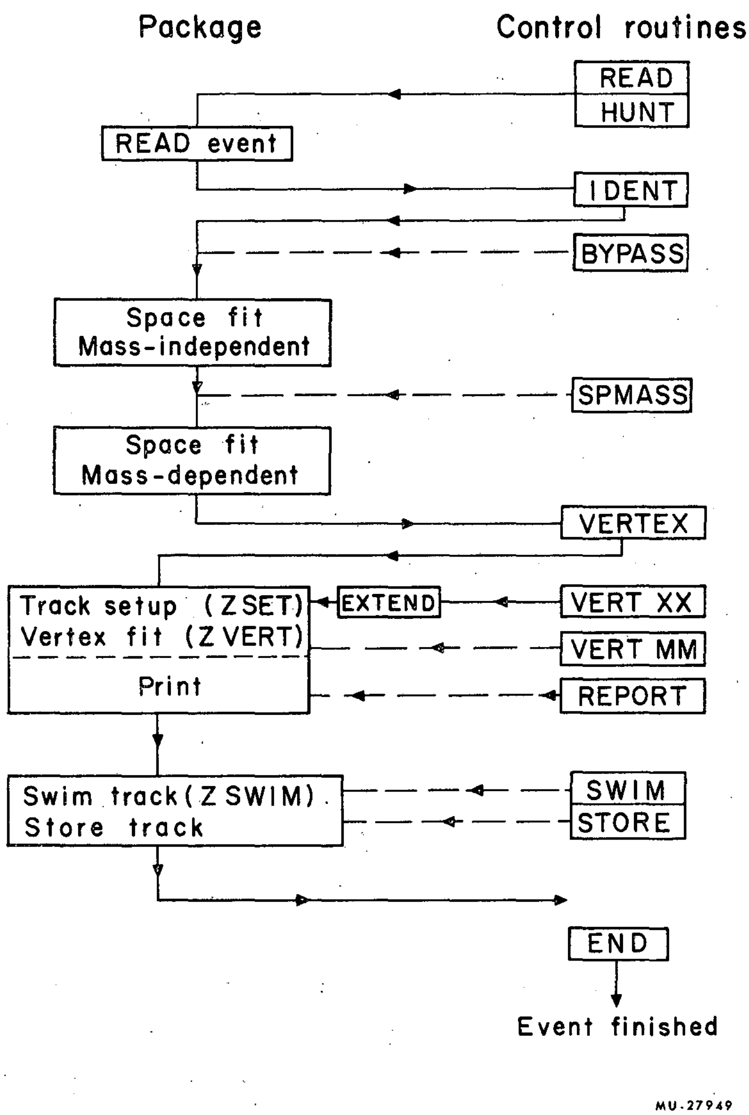

Fig. 6. Block diagram.

PREPARING DRAWINGS FOR JOURNALS

"The Physical Review" and "Physical Review Letters" published by the American Institute of Physics, are two of the journals most often used by the Laboratory scientific staff for publication. This being the case, the Information Division prepares most reports to fit their format. This saves time in publishing articles because the journal editors do not have to re-edit the material.

The journals want the graphs without captions; their printers set the captions in the type. To prevent the drawings' going astray, write the figure number and the author's name in pencil on the border of the drawing. The report typist prepares a separate list of figure numbers and captions for the journal.

Reduction is the main problem the illustrator faces in preparing work for journals. Journal columns are usually only 3 in. wide and the lettering must print not less than 1/16 in. high when reduced to fit the column.

Figure 7 gives a rule of thumb to pick correct lettering size. The width in inches is the measurement of the inked drawing, including the lettering on the ordinate of the graph.

Sample reductions are shown in further detail in Table V in the Appendix.

PHOTOGRAPHS

Continuous-tone prints are used extensively in UCRL reports. A print should have brilliancy and full detail in the shadows. The reproduction of the print never improves the quality of the picture, so it should be good to start with.

Normally the illustrators do not handle photographs for UCRL reports. The author hands in his material to Information Division. An editor separates the drawings from the text and sends them to the illustrators, and usually gives photographs directly to the photoclerks. Only if retouching or printing has to be added to a photo is it sent to the illustrators.

Glossy prints do not take ink well, so if it is necessary to letter with the Leroy directly on the print, first roughen the surface with an eraser. Otherwise, use paste-on letters and arrows. Overlays on acetate registered

WIDTH OF DRAWING (approximate)	LEROY SCALE	LEROY PEN	•BORDER• PELIKAN GRAPHOS PEN	•BORDER• LEROY PEN
7-in.	200	1		2
10-in.	240	2	0.8	2
12-in.	290	3	0.8	2
14-in.	350	4	1.0	3
16-in.	425	5	1.0	3
18 + in.	500	6	1.25	3

MUB-2047

Fig. 7. Lettering standards.

to the photo can be used when the report is going to be printed by the reproduction section of Graphic Arts. The photographers can also make a double burn and put the combined lettering and photo on one print. This is handy when the print has to go to a journal.

Just how the illustrator does the job is dependent on how much time he has and where the job is going to be sent.

MECHANICAL ENGINEERING DRAWINGS

Orthographic Projection

Illustrators are often called upon to do isometric or perspective drawings from engineering prints, so an illustrator must know how to read such prints. Blueprints have a visual symbolism used for conformity, allowing engineers to read information from one another's drawings without difficulty.

A blueprint represents a three-dimensional object on a flat plane. The projection of a three-dimensional object onto a flat plane is called orthographic projection.

There are six principal views of an object in third-angle orthographic projection, as shown in Fig. 8. This figure shows an object placed in a transparent box hinged at the edges. The projections on the sides of the box are the views seen by looking straight at the object through each side. If the outlines are scribed on each surface and the box opened as shown and laid flat, the result is a six-view third-angle orthographic-projection drawing. However, it is seldom necessary to draw all six views to portray an object clearly for illustration.

Only those views necessary to illustrate the required characteristics of the object should be drawn. Selected views should clearly depict the object with the use of as few hidden lines as possible.

Hidden Surfaces

To provide continuity from one view to another, hidden surfaces are represented by light dashed lines, as shown in Fig. 9.

Cross Sections

The cross section is the view most commonly shown in UCRL reports. Authors usually prefer to show a cross section rather than the three views of an orthographic drawing. This is especially true of any round object (symmetrical about its central axis).

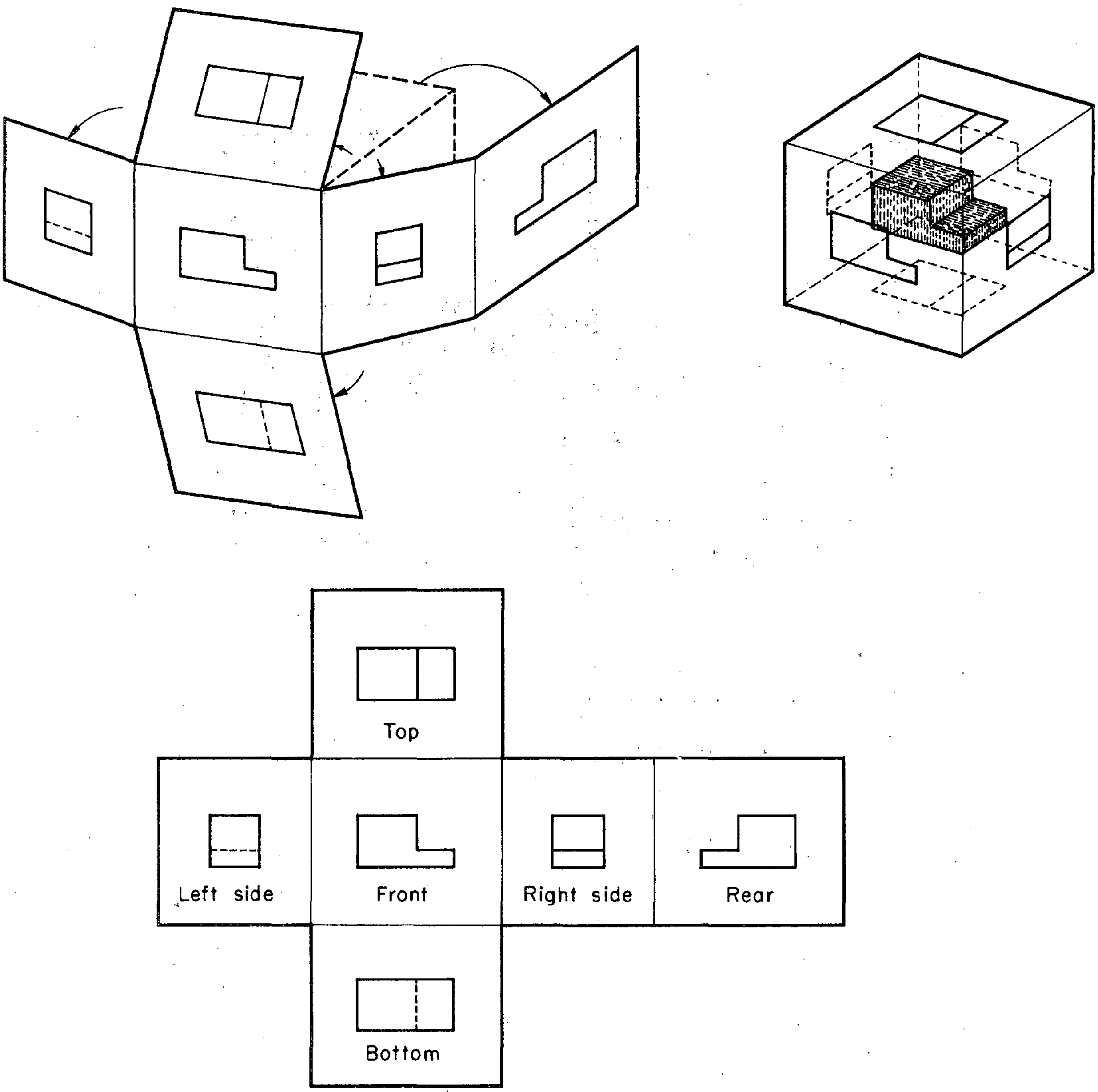

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Fig. 8. Third-angle orthographic projection.

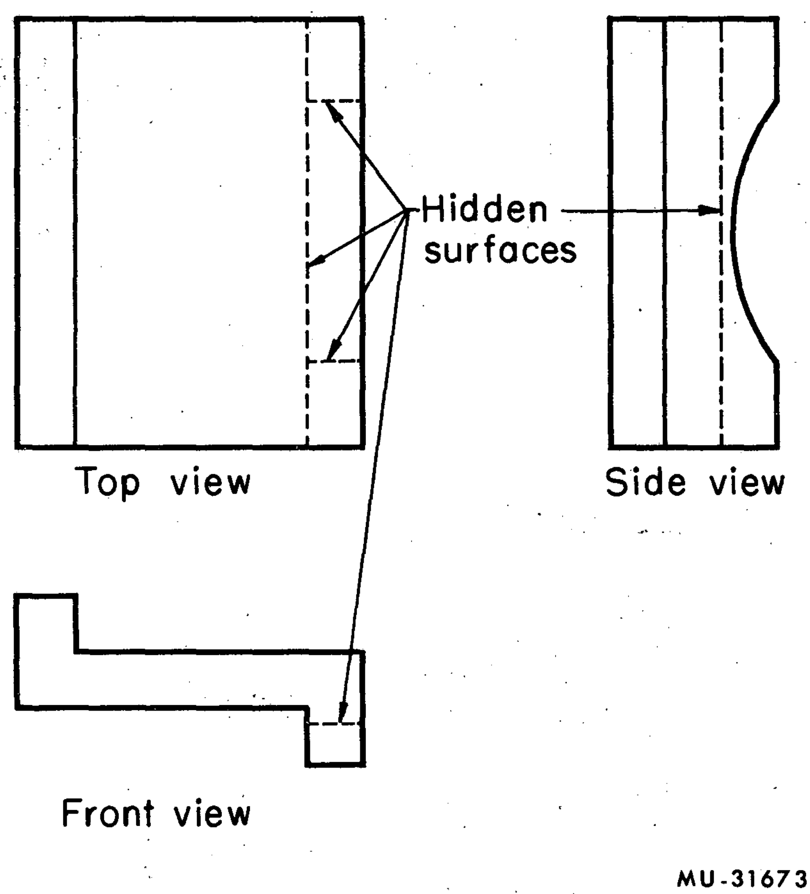


Fig. 9. Three-view arrangement showing hidden planes.

The engineering symbol for a cross section is a dash-dot-dot (——--) line cutting through the plan or side view where the cut is to be made. Arrows at the end of the cross-section line are directional. They indicate the direction the viewer is supposed to be looking, in relation to the plane of the drawing. The arrow points have letters on them which identify the different cross-section views that might appear on the same blueprint (see Fig. 10).

Materials such as steel, wood, etc. are shown symbolically by standard cross-hatching symbols which can be seen in Table IX of the Appendix.

To change engineering drawings into UCRL report illustrations requires some changes in form. Engineering drawings have parts lists, title blocks, dimensions, and special notes; these seldom have any place on a report illustration. Changing the form mainly involves leaving out extraneous information. Call-outs are put close by the part called out and are connected by an arrow. Where numbers are used on the engineering drawing, substitute the name of the part when changing to a report illustration (see Fig. 11).

Electrical Schematics

Electrical schematics (see Fig. 12) are simplified representations of electrical wiring and equipment. Wiring is shown on a flat plane with all the connections, capacitors, tubes, and switches indicated by standard symbols. Lettering should conform to LRL standards. Delete all extraneous information.

Wherever possible, Information Division wants all rough draft electronic schematics to be checked by the Electronics Department drafting room to make sure the author is using the approved symbols and layout.

Energy-Level Diagrams

Chemistry Department reports use a lot of energy-level diagrams (see Fig. 13). These show what stages an element goes through in changing its form This type of drawing has to follow a certain format or it has no meaning.

Make the chemical symbols larger than the rest of the lettering. Superscripts and subscripts should be two sizes smaller and be moved up or down, half the height of the lettering used. Make sure the superscripts and subscripts are close enough to the chemical symbol so there can be no confusion as to what they are describing.

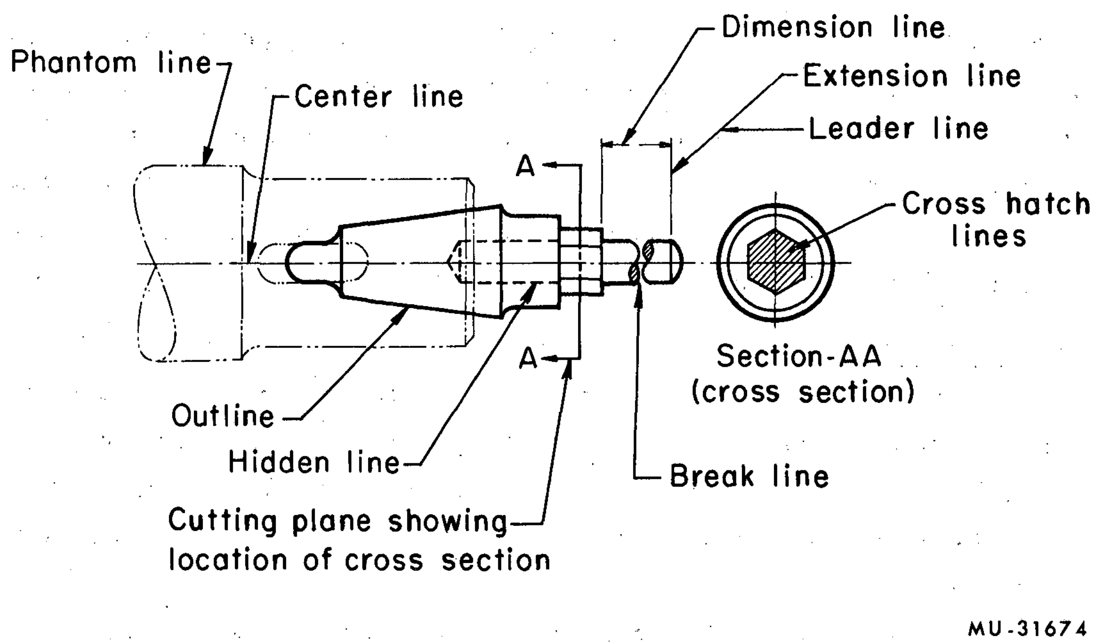
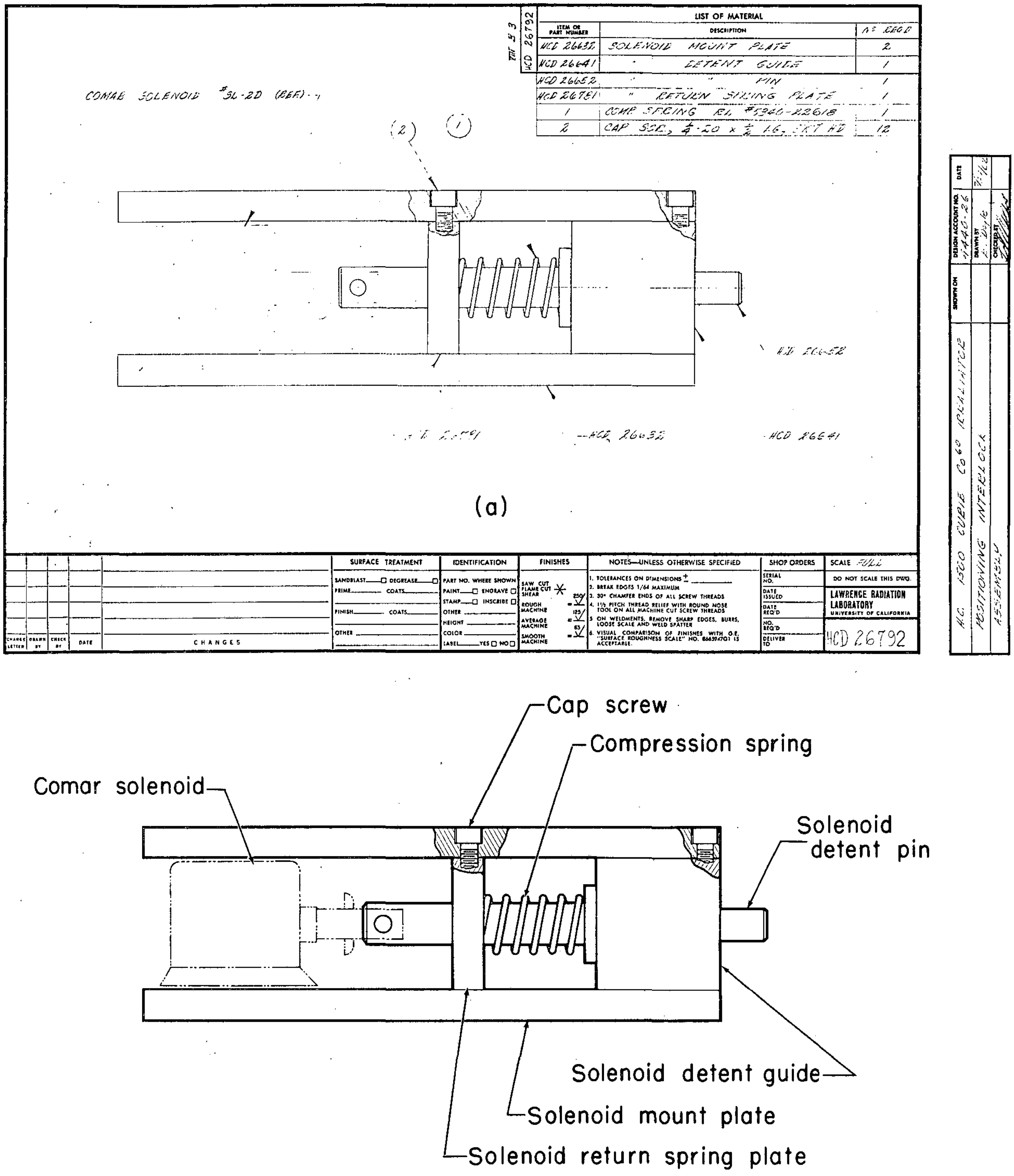


Fig. 10. Typical cross section.



(a)

(b)

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Fig. 11. Typical report drawing made from an engineering drawing.

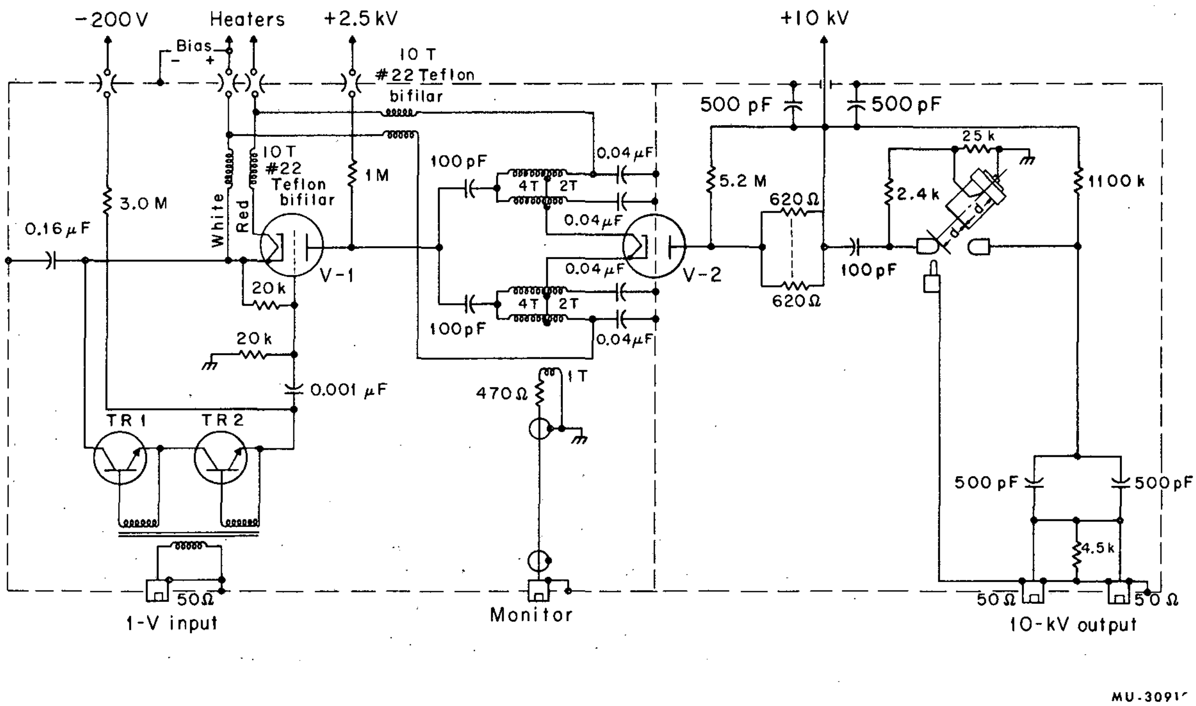

Fig. 12. Typical electronic schematic.

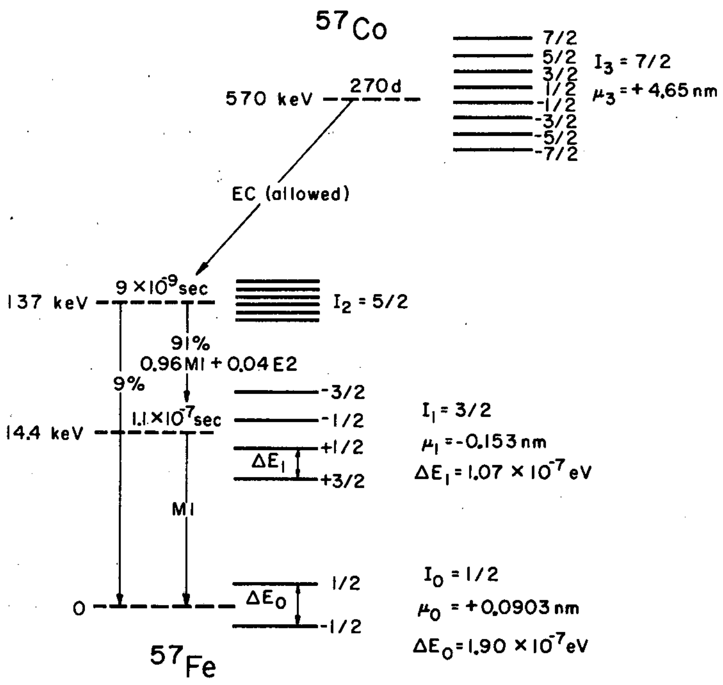

Fig. 13. Energy-level diagram.

The columns of lettering must be lined up. Make the horizontal bars twice as heavy as the connecting lines.

The full list of chemical symbols is shown in Table I of the Appendix.

THREE-DIMENSIONAL ILLUSTRATION

Isometric Drawing

Isometric drawing is the simplest form of axonometric projection. To make an isometric drawing, if the object is rectangular, start with a point representing a front corner and draw from it three isometric axes 120 deg apart. With a 30-deg triangle, draw one vertical line and the other two with the 30-deg side of the triangle (see Fig. 14). This is called the first position.

On these three lines measure the height, width, and depth of the object. All measurements are made at full scale along the axes. Because the sides of the object are drawn parallel, a measurement can be made along one axis and a plane constructed from that point by using the 30-deg triangle, as shown in Fig. 15.

It is often more convenient to build up an isometric drawing from the lower front corner. This arrangement is called the second position (see Fig. 16).

Dimetric Projection

Dimetric projection (see Fig. 17) is a nice change from isometric drawing, when a resemblance to perspective is required. It has the advantage of being a measurable drawing and looking foreshortened even though the sides are parallel. The effect is achieved by making measurements on the vertical and 7-deg axes at full scale, while measurements along the 41-deg axis are made at half scale.

Perspective

Two-point perspective, as shown in Fig. 18, is all that is normally required. In this form of perspective the artist uses two vanishing points with parallel vertical lines for any lines not going to a vanishing point. Perspective charts are available in many sizes and are quicker and easier to use than to project the drawing from a plan and side view.

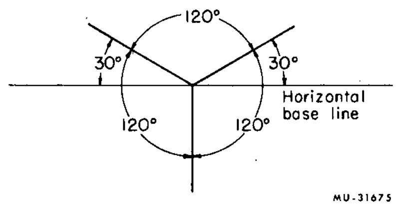

Fig. 14. First step in construction of an isometric drawing.

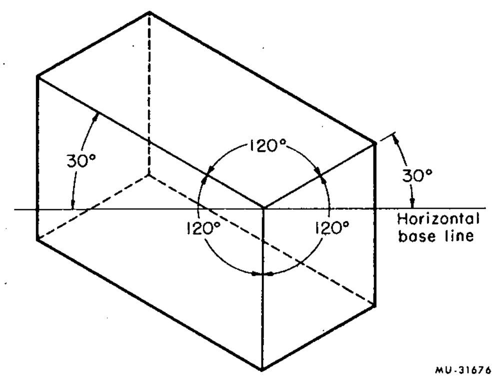

Fig. 15. Isometric drawing, first position.

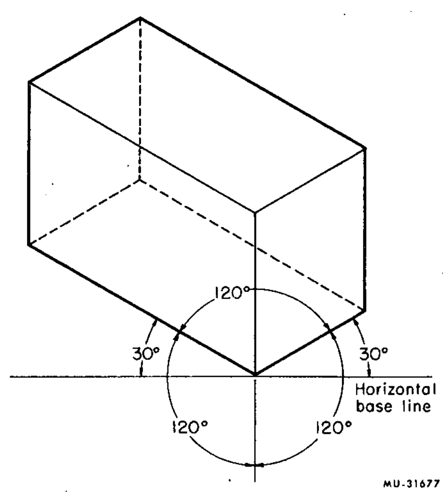

Fig. 16. Isometric drawing, second position.

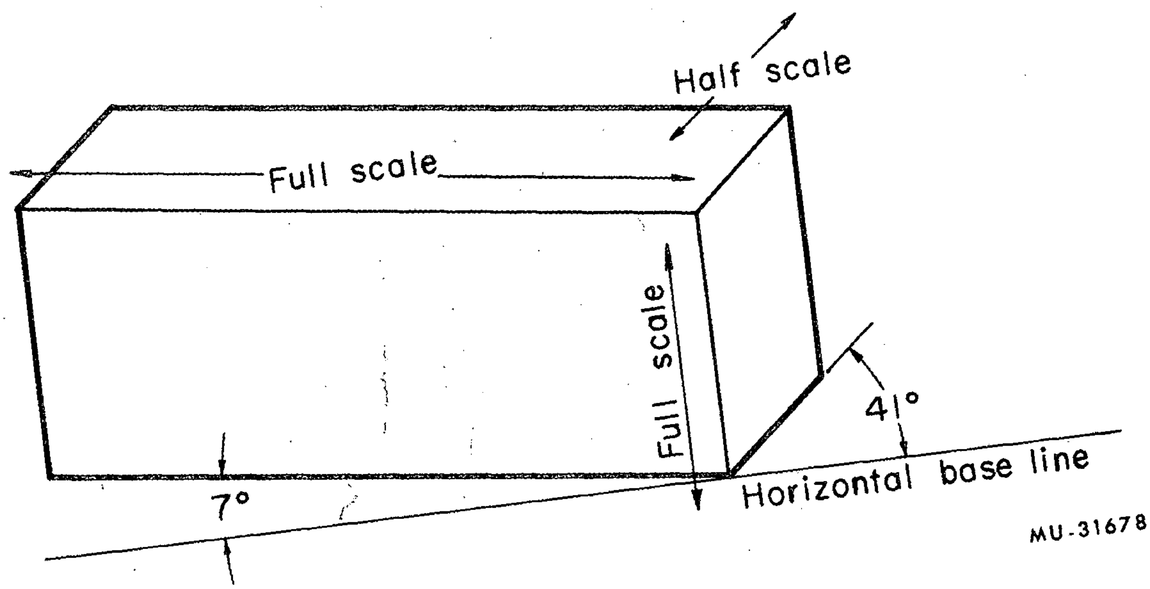

Fig. 17. Dimetric projection.

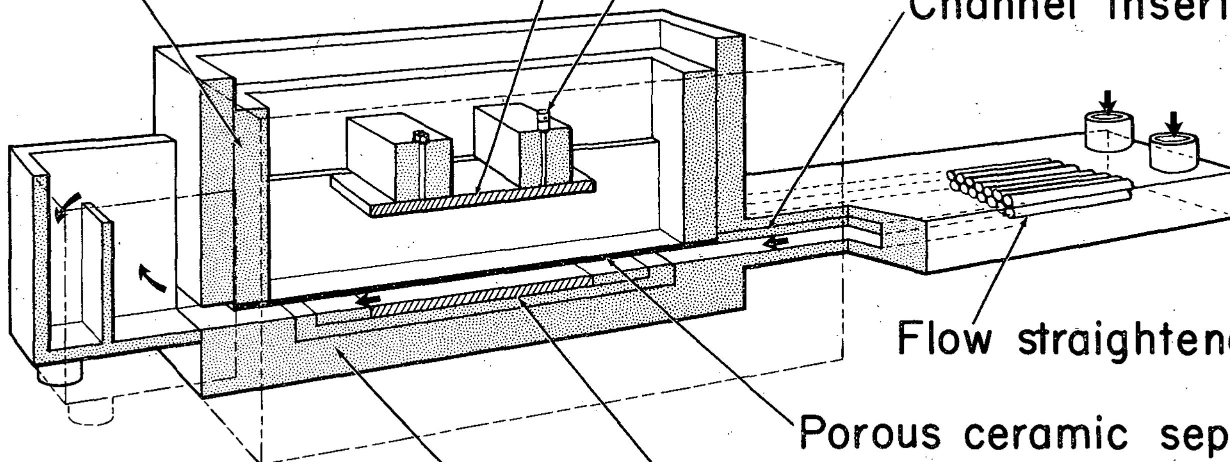

Fig. 18. Typical two-point perspective drawing.

Shading

The illustrators can use any one of three different types of shading to enhance the feeling of form in their drawings:

1. Mechanical shading (Fig. 19),
2. Shading by tone (Fig. 20),
3. Shading by line weights (Fig. 21).

Mechanical shading is done with drafting instruments and uses clean crisp lines to give a feeling of form.

Shading by tone gives a softer feeling of form by blending one tone into another.

Shading by line weights is used where areas of tone would obstruct the readability of the drawing. The sun is thought of as shining at a 45-deg angle from either the upper right or upper left of the drawing. The surfaces closest to the source of light are made light and the surfaces away from the light are rendered heavy.

NONREPORT ILLUSTRATION

Presentation Illustration

A special type of drawing is necessary when used as an aid to lectures. Ideally, it needs to be large, colorful, and simple.

Find out what main point is being discussed and make the drawing a simple and forceful statement of that point. The drawing can be a graph, airbrush rendering, or paper cut-out as long as it gets the point across.

One good method is to use colored illustration board with a rendering cut out of Coloraid paper and pasted down, with headliner lettering for call-outs, and chart tapes for line work (see Fig. 22).

Flip charts are made with simple sentences written with a felt pen or painted with a lettering brush and poster paint. The lecturer turns the pages as he talks, to illustrate special points he wants to make.

REPORT PROCESSING

The block diagram shown in Fig. 23 illustrates the work flow that a typical report follows from the time it first enters the Information Division until it is finally distributed.

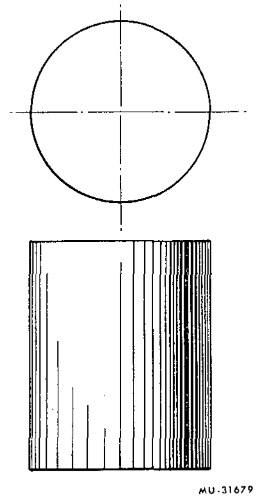

Fig. 19. Mechanical shading.

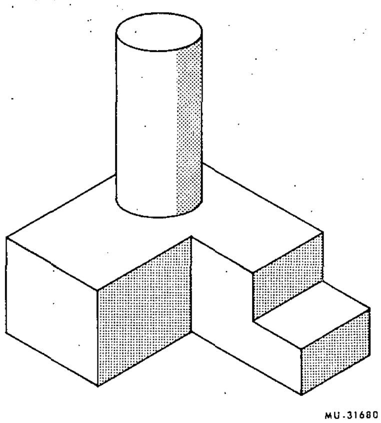

Fig. 20. Shading by tone.

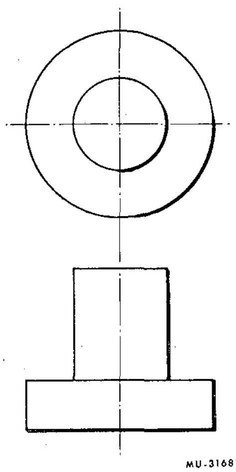

Fig. 21. Shading by line weight.

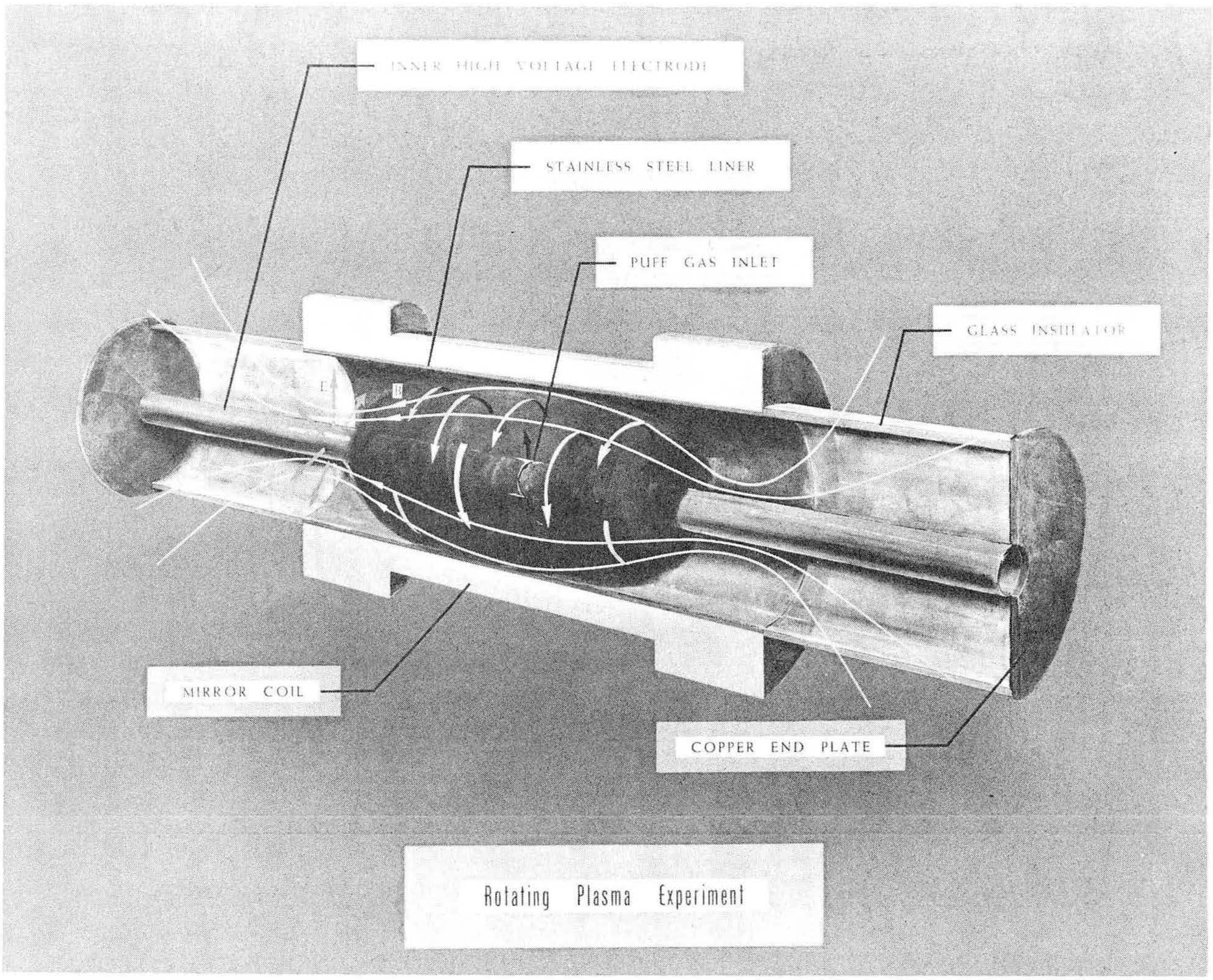

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Fig. 22. Presentation drawing.

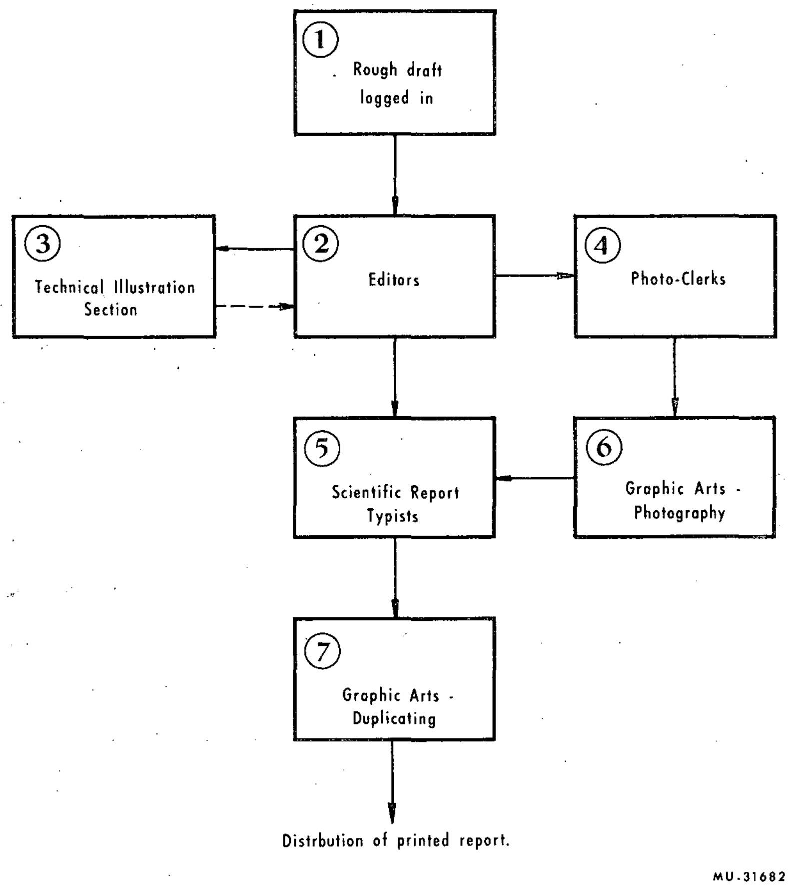


Fig. 23. Report work flow.

1. The rough draft is logged in the publication section of the Information Division and is assigned a UCRL report number.

2. One of the editors edits the text and drawings, making sure the material is in proper LRL format. Editing symbols are shown in Table II of the Appendix.

3. The editor separates the figures to be drawn from the rough draft and sends them to the Illustration Section. The drawing rough drafts are logged in by date, UCRL number, and the author's name. They are kept together in the work drawer until their turn to be drawn.

The illustrator renders the rough drawing into an inked drawing in the proper form, then gives each drawing a drawing number which is entered in the drawing logbook. At this time the rough-draft logbook is closed out by writing in the date that the job is completed. After the author has approved the drawings for accuracy, they are returned to the editor who double-checks them and sends them to the photo clerks. When the drawings leave the illustrators' office, a notation is made of the date and who picks up the job.

4. The photo clerks handle all ordering of negatives, prints, and slides that have to be made by the Photography Section of the Graphic Arts Department.

The photo clerks file the negatives by means of an MU or MUB number which is affixed to the drawing in the lower right-hand corner. The original inked drawing is also filed in their office by its drawing number. For convenience, a record is kept by both drawing and MU numbers so that if the MU number is known, the drawing number can be found.

Standard negative sizes are 5 by 7 in. for MU and 8 by 10 in. for MUB.

5. The scientific report typists usually type the text on multilith mats while the drawings are prepared. When the drawing negatives have been made, they are mounted and sent with the text to the Duplicating Section of the Graphic Arts Department.

6. Reports are printed on Multilith machines by the Duplicating Section. After a report has been printed and bound, copies are mailed out to the various laboratories and scientists on the authorized mailing list.

Special Publications

Brochures and booklets are handled separately from the main report and slide work. A special publication section coordinates all editing, art work, and printing for the publication. Each special publication is given a number called a "Pub" number. Combined with this number is a notation showing the number of copies printed and the date of publication. For example,

Pub. 47
5M
Jan. 1963.

The first number identifies the publication; under this number is filed all information regarding this specific publication. The 5M stands for 5,000 copies, and the date is the date of that particular run.

Information regarding all such publications is kept in the Technical Information Division.

APPENDIX

Table I. Symbols of the chemical elements.

Ar	Argon
Ac	Actinium
Ag	Silver
Al	Aluminum
Am	Americium
As	Arsenic
At	Astatine
Au	Gold
B	Boron
Ba	Barium
Be	Beryllium
Bi	Bismuth
Bk	Berkelium
Br	Bromine
C	Carbon
Ca	Calcium
Cd	Cadmium
Ce	Cerium
Cf	Californium
Cl	Chlorine
Cm	Curium
Co	Cobalt
Cr	Chromium
Cs	Cesium
Cu	Copper
Dy	Dysprosium
Es	Einsteinium
Em	Emanation
Er	Erbium
Eu	Europium
F	Fluorine
Fe	Iron
Fm	Fermium
Fr	Francium
Ga	Gallium
Gd	Gadolinium
Ge	Germanium
H	Hydrogen
He	Helium
Hf	Hafnium
Hg	Mercury
Ho	Holmium
I	Iodine
In	Indium
Ir	Iridium
K	Potassium
Kr	Krypton
La	Lanthanum
Li	Lithium
Lu	Lutetium
Lw	Lawrencium
Mg	Magnesium
Mn	Manganese
Mo	Molybdenum
Md	Mendelevium
N	Nitrogen
Na	Sodium
Nb	Niobium
Nd	Neodymium
Ne	Neon
Ni	Nickel
Np	Neptunium
O	Oxygen
Os	Osmium
P	Phosphorus
Pa	Protactinium
Pb	Lead
Pd	Palladium
Pm	Promethium
Po	Polonium
Pr	Praseodymium
Pt	Platinum
Pu	Plutonium
Ra	Radium
Rb	Rubidium
Re	Rhenium
Rh	Rhodium
Rn	Radon
Ru	Ruthenium
S	Sulfur
Sb	Antimony
Sc	Scandium
Se	Selenium
Si	Silicon
Sm	Samarium
Sn	Tin
Sr	Strontium
Ta	Tantalum
Tb	Terbium
Tc	Technetium
Te	Tellurium
Th	Thorium
Ti	Titanium
Tl	Thallium
Tm	Thulium
U	Uranium
V	Vanadium
W	Tungsten (Wolfram)
Xe	Xenon
Y	Yttrium
Yb	Ytterbium
Zn	Zinc
Zr	Zirconium

Table II. Signs used in correcting proofs for AIP publications.

	Delete; take out.
	Turn inverted letter right side up.
stet	Let it remain; change made was wrong.
□	Indent one *em*.
⊙	Insert a period.
‖	The type line is uneven at the side of the page; straighten.
×	A broken letter.
=	A hyphen.
ital.	Use italics.
⁀	Join together.
	Take out letter and close up.
center	Put in middle of page, or line.
	Straighten lines.
	Insert an apostrophe.
	Insert a comma.
	Raise the word or letter.
	Lower the word or letter.
	Bring matter to the left.
	Bring matter to the right.
#	Make a space.
	Insert a superior letter or numeral.
	Insert an inferior letter or numeral.
lead	A thin metal strip used to widen the space between the lines.
space out	Spread words farther apart.
¶	Make a paragraph.
no ¶	Run on without a paragraph.
cap.	Use a capital.
l.c.	Use the lower case (small type), *i.e.*, not capitals.
s.c.	Small capitals.
w.f.	Wrong font—size or style.
font.	Kind of type.
tr.	Transpose.
rom.	Use roman letter.
∧	Indicates where an insertion is to be made.
Qy. or (?)	Doubt as to spelling, etc.
	Indicates CAPITAL letters.
	Indicates SMALL CAPITAL letters.
	Indicates *italic* letters.
	Indicates **black type** letters.
	Indicates **BLACK CAPITALS.**
	Indicates ***black italic.***

Table III. Prefixes for denoting multiples and submultiples of units.[a]

Multiples and Submultiples	Prefixes	Symbols
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

[a]At its October 1962 meeting in Paris the International Committee on Weights and Measures adopted two new prefixes for denoting submultiples of units. They are: femto, 10^{-15}, symbol "f," and atto, 10^{-18}, symbol "a." This brings the list of numerical prefixes to a total of 14.

Table IV. The Greek alphabet and common uses.

Letters Capital	Small	Name	Common Uses
Α	α	Alpha	Angles, coefficients
Β	β	Beta	Angles, coefficients
Γ	γ	Gamma	Angles, coefficients, specific gravity, conductivity
Δ	δ	Delta	Angles, coefficients, density, variation
Ε	ϵ	Epsilon	Base of hyperbolic logarithms, eccentricity in conic sections
Ζ	ζ	Zeta	Coordinates, coefficients
Η	η	Eta	Coordinates, coefficients, hysteresis (Steinmetz) coefficient, efficiency
Θ	θ	Theta	Angles, angular phase displacement, time constant
Ι	ι	Iota	
Κ	κ	Kappa	Dielectric constant, susceptibility
Λ	λ	Lambda	Angles, coefficients, latitude, wavelength
Μ	μ	Mu	Angles, coefficients, permeability
Ν	ν	Nu	Angles, coefficients, reluctivity
Ξ	ξ	Xi	Coordinates, output coefficient
Ο	ο	Omicron	
Π	π	Pi	Circumference ÷ diameter
Ρ	ρ	Rho	Radius, ratio, resistivity
Σ	σ	Sigma	Distance (space), sum, (cap) summation, leakage coefficient
Τ	τ	Tau	Temperature, time, time-phase, displacement, time constant
Υ	υ	Upsilon	
Φ	ϕ	Phi	Angles, coefficient, flux
Χ	χ	Chi	
Ψ	ψ	Psi	Angles, angular velocity in time
Ω	ω	Omega	Angular velocities, angular velocity in space

Table V. Samples of lettering reduction.

The Leroy lettering was done with varying line weights and lettering sizes. Drawings were reduced to A. I. P. column width of three inches, thus graphically showing the effect of reduction on different sizes of drawings.

The drawings are coded as follows: B stands for border; the number following B stands for the Pelikan Graphos Pen of the T series in that size (0.8, 1, 1.25).

Pen-0, Pen-1, etc., shows what happens when different sizes of Leroy pens are used in combination with varying Leroy lettering-scale sizes.

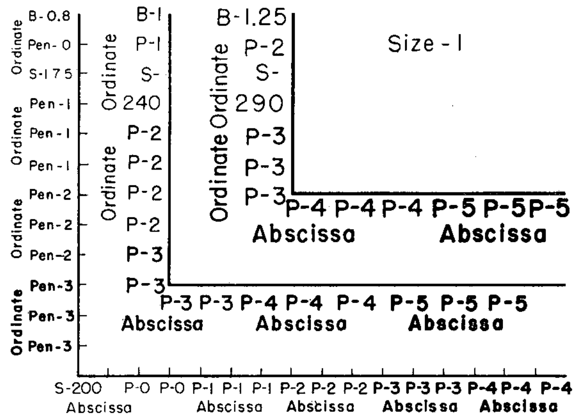
S-175, S-200, etc., is the Leroy scale number showing which size of lettering guide was used.

(a) Shows the effect of reduction to three inches of lettering done on a size 1 piece of paper (8-1/2 × 11 in.).

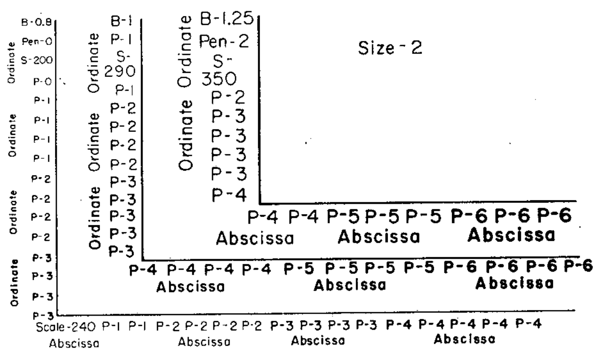
(b) Lettering done on a size 2 piece of paper (11 × 17 in.) and then reduced to three inches.

(c) Reduction to three inches of lettering done on a size 3 piece of paper (17 × 22 in.).

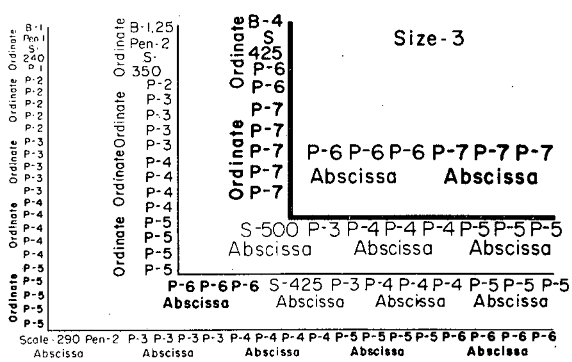
Table V (cont.)



(a)



(b)



(c)

Table VI. Abbreviations.
(From UCRL-8543 Rev. 3, February 1966)

about (circa—dates only)	ca	barn	b
absolute	abs	billion electron volts	GeV [or BeV]
absolute ampere(s)	abamp	boiling point	bp
acceleration due to gravity	g	British thermal unit(s)	Btu
alternating current (n) or alternating-current (adj)	ac	calculated	calc
ampere(s)	A	calorie(s) (gram)	cal
ampere-hour(s)	Ah	Calorie(s)	see kcal
ampere-turn(s)	A-turn	capacitance	C
and others	et al.	center of mass (n) or center-of-mass (adj)	c.m.
angstrom unit(s)	Å	centimeter(s)	cm
aperture ratio 16	*f*/16	centimeter-gram-second (system)	cgs
approximate(ly)	approx	centimeter(s) per second	cm/sec
approximately equal to	≈	Chapter	Chap.
asymptotically equal to	~	chemically pure	cp
atmosphere(s) (unit)	atm	coefficient	coeff
atomic mass unit(s)	amu	compare	cf
atomic number	at. no. [or Z]	constant	const
atomic percent	at. %	continuous-wave	cw
atomic weight	at. wt [or A]	coulomb	C
atomic weight unit(s)	awu	counts per minute	counts/min
		counts per second	counts/sec
audio frequency (n) or audio-frequency (adj)	af	cubic	cu [or ^{3}]
average	av	cubic centimeter(s)	cm^3 or cc

cubic foot (feet)	ft^3
cubic feet per minute	cfm
cubic feet per second	cfs
cubic inch(es)	$in.^3$
cubic meter(s)	m^3
cubic millimeter(s)	mm^3
curie(s)	Ci
cycle(s) per second	cps [or Hz]
debye	D
decibel(s)	dB
degree(s) (angle)	deg
degree(s)Celsius(centigrade)	°C
degree(s) Fahrenheit	°F
degree(s) Kelvin (absolute)	°K
density	d or ρ
derivative	deriv
deuteron(s)	d
diameter	diam
direct current (n) or direct-current (adj)	dc
disintegration(s) per sec	dis/sec
drawing number	dwg no.
edition	ed
editor (editors)	Ed. (Eds.)
efficiency	eff
electromagnetic unit(s)	emu
electromotive force	emf
electron volt(s)	eV
electrostatic unit(s)	esu
entropy unit(s)	eu
Equation(s)*	Eq. (Eqs.)
equivalent	equiv
erg second(s)	erg sec
exponent or exponential	exp
farad(s)	F
feet per minute	fpm
feet per second	fps
fermi (=10^{-13} cm)	F
Figure (Figures)*	Fig. (Figs.)
foot (feet)	ft
foot-pound	ft-lb
for example	e. g.
freezing point	fp
frequency	freq
frequency, high	hf
, low	lf
, medium	mf
, super high	shf
, ultrahigh	uhf
, very high	vhf
, very low	vlf
, video	vdf
frequency modulation	FM

*Not abbreviated when it is the first word of a sentence.

functions, hyperbolic:	
cosecant	csch
cosine	cosh
cotangent	coth
secant	sech
sine	sinh
tangent	tanh
functions, trigonometric:	
cosecant	csc
cosine	cos
cotangent	cot
secant	sec
sine	sin
tangent	tan
coversed sine	covers
versed sine	vers
gallons per minute	gpm
gauss	G
Geiger-Mueller [or Müller]	G-M
giga (10^9)	G
giga electron volts	GeV [or BeV]
gilbert	Gi
gram(s)	g
gram calorie(s)	cal
gram-molecular volume	gmv
grams per liter	g/l
gram(s) per cubic centimeter	g/cm^3 or g/cc
gravity, acceleration of	g
henry(s)	H
hertz (cycles per second)	Hz
high explosive	H. E.
high voltage	hv
horsepower	hp
hour(s)	h[or hr]
hyperfine structure	hfs
in the place cited	loc. cit.
in the same place	ibid.
in the work cited	op. cit.
inch(es)	in.
inch-pound(s)	in. -lb
inductance	L
inductance-capacitance	LC
infrared	ir
inside diameter	i. d.
internal resistance	spell out
joule(s)	J
kilocalorie(s) or kilogramcalorie(s)	kcal
kilocalorie(s) per mole	kcal/mole
kilocycle(s)	kc
kilocycle(s) per second	kc [or kc/sec]
kilocurie(s)	kCi
kiloelectron volt(s)	keV
kilogauss	kG
kilogram(s)	kg
kilogram-meter(s)	kg-m
kilogram(s) per cubic meter	kg/m^3
kilohm	kΩ
kilojoule(s)	kJ
kiloliter(s)	kl

kilomegacycle	kMc
kilometer(s)	km
kilometer(s) per second	km/sec
kilo-oersted	kOe
kiloton(s)	kt
kilovolt(s)	kV
kilovolt-ampere(s)	kVA
kilowatt(s)	kW
kilowatt-hour(s)	kWh
kinetic	kin
kinetic energy	KE
laboratory (system)	lab
lambert(s)	L
lethal dose (subscript denotes percent)	LD_{50}
liter(s)	spell out
logarithm, base of natural	e
logarithm (common)	log
logarithm (natural)	ln [or $\log_e$]
mass	spell out
maximum	max
maxwell	Mx
mean free path	mfp
megacurie(s)	MCi
megacycle(s)	Mc
megacycle(s) per second	Mc [or Mc/sec]
megavolt-ampere(s)	MVA
megaton(s)	Mt
megawatt(s)	MW
megawatt-hour(s)	MWh
megohm(s)	MΩ
melting point	mp
meter(s)	m
meter-kilogram-second (system)	mks
mho(s)	spell out
microampere(s)	μA
microangstrom(s)	μÅ
microcoulomb(s)	μC
microcurie(s)	μCi
microfarad(s)	μF
microgram(s)	μg
microhenry(s)	μH
microliter	μl
micromho(s)	μmho
micromicron(s)	μμ
micromicrosecond(s) [or picosecond(s),	μμsec psec]
micromole(s)	μM
micron	μ
microsecond(s)	μsec
microvolt(s)	μV
microwatt(s)	μW
mil(s)	spell out
milliampere(s)	mA
milliangstrom(s)	mÅ

millibarn(s)	mb
millicurie(s)	mCi
milliequivalents	meq
millifarad(s)	mF
milligram(s)	mg
milligram percent	mg/100 cc
millihenry(s)	mH
millilambert(s)	mL
milliliter(s)	ml
milli-mass units	mmu
millimeter(s)	mm
millimeter(s) of mercury [1 torr]	mm Hg
millimho(s)	mmho
millimicron(s)	mμ
millimicrosecond(s) [or nanosecond(s),	mμsec nsec]
millimole(s)	mM
million electron volts	MeV
million volts	MV
milliradian(s)	mr
milliroentgen(s)	mR
millisecond(s)	msec
millivolt(s)	mV
milliwatt(s)	mW
minimum	min
minute(s)(angular measure)	'
minute(s) (time)	min

molar (with number only, e.g. 0.5 M)	M
mole	spell out
mole percent	M% [or mole %]
molecular weight	mol wt
motor generator (n or adj)	m. g.
nano (10^{-9})	n
nanosecond(s)	nsec
natural logarithm	ln [or $\log_e$]
neutron(s)	n
normal (solutions; with numbers only, e.g. 0.5 N)	N
nuclear magneton	nm
nucleon(s)	N
Number(s)*	No. (Nos.)
observed	obs
oersted	Oe
ohm(s)	Ω
optical density	OD
outside diameter	o. d.
page	p.
pages	pp.
part(s) per million	ppm
percent	%
pico (10^{-12})	p
picofarad	pF
pound(s) per square inch	psi
pound(s) per square inch, absolute	psia

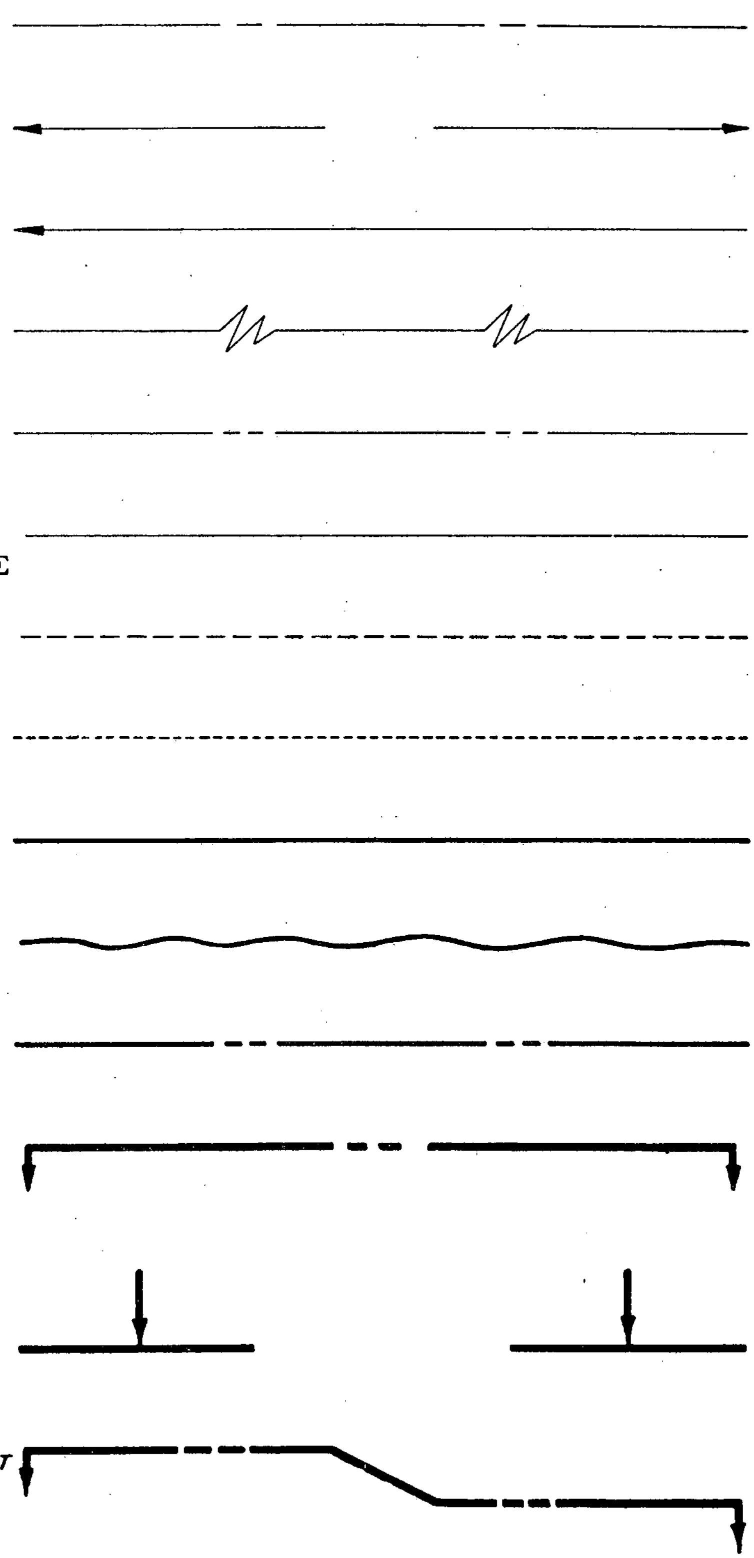
pound(s) per square inch, gauge	psig	speed of light	c
proportional to (or varies as)	$\propto$	square	sq or ^{2}
proton(s)	p	square centimeter(s)	cm^2
pulse(s) per second	pps	square foot (feet)	ft^2
radian	rad	square inch(es)	in.^{2}
radiation absorbed dose	rad	square kilometer(s)	km^2
radio frequency (n) or radio-frequency (adj)	rf	square meter(s)	m^2
rate of flow	Rf	square micron(s)	μ^2
relative biological effectiveness (of radiation)	RBE	square millimeter(s)	mm^2
resistance	R	standard	std
revolutions per minute	rpm	standard cubic feet	scf
revolutions per second	rps	standard temperature and pressure	STP
roentgen(s)	R	steradian(s)	sr
roentgen equivalent, man	rem	temperature	temp
roentgen equivalent, physical	rep	that is	i. e.
root-mean-square	rms	thermocouple	TC
second(s) (angular measure)	"	thousand electron volts	keV
second(s) (time)	sec	thousand tons	kt
Section(s)*	Sec. (Secs.)	ton(s)	spell out
soluble	sol	torr [1 mm Hg]	spell out
solution	soln	triton(s)	t
specific activity	sp act.	ultrahigh frequency	uhf
specific gravity	sp gr	ultraviolet	uv
specific heat	sp ht	velocity	v
specific volume	sp vol	versus	vs
		volt(s)	V
		volt-ampere(s)	VA

volume	vol	weight	wt
volume percent	vol %	weight percent	wt %
watt(s)	W	year(s)	yr
watt-hour	Wh		

Table VII. Mathematical symbols.

$\{\ \}$	Brace (or "face bracket")	$+$	Addition sign
$[\ ]$	Bracket	$\times$	Multiplication sign
$\int \int$	Two sizes of integral signs	∞	Infinity
$\sqrt{\ }$	Square root sign (or radical)	Δ	Cap delta—usually indicates an increment
$\sum$	Cap sigma—used to indicate summation	∇	Del (or nabla)—used in special math
$\pm$	Plus or minus	$\perp$	Perpendicular to
$\mp$	Minus or plus	$!$	Factorial sign (special math)
$\cong$	Congruent	$\rceil$	Used in financial math
$\equiv$	Identical to	$\sqrt{\ }$	(Smaller) square root sign
$\neq$	Not equal to	$\leftarrow$ $\rightarrow$	Directional arrows—used in several ways
$\approx$	Approximately equal to	#	Sign for "number"
$\propto$	Proportional sign	∂	"Partial" sign (as in $\partial x/\partial y$)
$\leq$	Equal to or less than (also, $\leqslant$ and $\leqq$)	d	Derivative sign (l. c. dee)
$\geq$	Equal to or greater than (also $\geqslant$ and $\geqq$)	e	Lower case e (base of natural logarithms)
$\sim$	Asymptotically equal to	"	Inch sign
$\div$	Division sign	$\parallel$	Parallel sign

Table VIII. Line Conventions.



CENTER LINE	THIN
DIMENSION	THIN
LEADER	THIN
BREAK (LONG)	THIN
PHANTOM	THIN
CROSS HATCH AND EXTENSION LINE	THIN
HIDDEN	MEDIUM
STITCH LINE	MEDIUM
OUTLINE OR VISIBLE LINE	THICK
BREAK (SHORT)	THICK
DATUM LINE	THICK
CUTTING PLANE	EXTRA THICK
VIEWING PLANE	EXTRA THICK
CUTTING PLANE FOR COMPLEX OR OFFSET VIEWS	EXTRA THICK

Table IX. Symbols for materials, sample Blu-Zip patterns.