ENGINEERING STANDARD

FOR

DRAFTING

CONTENTS :

PAGE No.

APPENDICES:

1. SCOPE

This Standard covers drafting design practices for technical drawing and prescribes the standards of line conventions and lettering, drawing sheet size and format, multi and sectional view scales, etc. to be used in Iranian Petroleum Industries for preparing drawings.

2. REFERENCES

Throughout this Standard the following standards and codes are referred to. The editions of these standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the Company and the Vendor/Consultant.

ANSI (AMERICAN NATIONAL STANDARDS INSTITUTE)

Y 14.36 (1978) "Surface Texture Symbols"

BSI (BRITISH STANDARDS INSTITUTION)

BS 1192 "Construction Drawing Practice"

3. DEFINITIONS AND TERMINOLOGY

In this Standard the below terms and definitions shall apply.

3.1 Definitions of Drawing and Prints

3.1.1 Drawings

Original drawings prepared by the Iranian Petroleum Industry or on their behalf, by a consultant and bearing and Engineering drawing number.

3.1.2 Maker's drawings

Prints & drawings received from outside sources.

3.1.3 Prints

Prints of: Drawings
Reproducible copies

3.1.4 Reproducible copies

Tracing prints of drawings, microfilms, statfiles, etc.

4. UNITS

This Standard is based on International System of Units (SI), except where otherwise specified.

5. DRAWING SPECIFICATION

5.1 Drawing Sheet Size

5.1.1 Selection and designation of sizes

The original drawing should be made on the smallest sheet permitting the necessary clarity and resolution.

The choice of sizes of the original drawing and its reproductions shall be made from the series shown in Sub-Clauses 5.12, 5.13.

Drawing sheets may be used with their longer sides positioned eitherhorizontally or vertically.

5.1.2 Sizes series

The sizes of the trimmed sheets as selected from the main A series, are given in Table 1.

TABLE 1

DESIGNATION	DIMENSIONS, mm
A0	841 × 1189
A1	594 × 841
A2	420 × 594
A3	297 × 420
A4	210 × 297

5.1.3 Exceptional elongated sizes

Exceptional elongated sizes are obtained by extending the shorter sides of a format of the A series to lengths that are multiples of the shorter side of the chosen basic format.

5.2 Drawing Materials

5.2.1 Drawings shall generally be prepared on standard pre-printed polyester film or tracing paper, and etc.

Study drawings, which will not be issued outside the engineering organization shall be made on plain tracing paper.

Note:

Type and number of drawings shall be as required by Company.

5.3 Handling of Drawings

Tracing paper tends to become brittle, especially after passage through the printing machine, and must be handled with care to avoid damage.

5.3.1 Binding of drawings

Drawing produced on tracing paper and tracing prints shall be edge bound.

5.3.2 Use of drawings and prints for reference

In order to maintain drawings in good condition and to reduce the possibility of loss, they should not be removed from the records office except for quick reference or working purposes and must be returned to the records office as soon as possible.

Prints should be taken where prolonged use in the drawing office and other departments is required.

6. DRAWING PRESENTATION

6.1 General

Drawing covering a project or a job shall generally include the following main features.

a) A site plan or layout drawing and detailed layout drawings locating new equipment with respect to existing equipment.

b) Detail drawings of buildings, structures, piping layouts, electrical or instrument installations, etc.

c) Where workshop fabrication is involved, drawings for pipe supports, pipehangers, machined parts, etc. should be shown on separate drawings.

Shop drawings should be sufficiently detailed to allow fabrication.

6.2 Presentation

a) Engineering drawings dimensions, arrowheads, and notes should be in ink. However if existing drawings can be used, it may be practical in order to make clear the additions and changes involved, to draw in ink.

b) A new drawing shall be made only if there are no existing drawings suitable for revision to show the new work. A thorough search for suitable existing drawings before preparing any new drawing should be carried out. This does not mean that there must be space on the existing drawing to show all the new work. For instance, it would be perfectly acceptable to revise an existing site plan to show the location of new equipment. If there is insufficient space on the existing drawing to show all the new details, these may be shown on a separate new drawing cross referenced to the existing drawing as revised.

6.3 Drawings shall be prepared for a clearly defined purpose and shall achieve this purpose in the most direct manner possible. The required information shall be presented clearly and accurately with the minimum use of lines, symbols, etc., and those used shall be easily recognizable and intelligible. Information that does not and in achieving the intended purpose shall be omitted.

Careful planning shall be carried out before the drawing is started to ensure good presentation, with sufficient space to show clearly all necessary details, notes, dimensions, item numbers etc.

6.4 Study or Preliminary Drawings

Study or preliminary drawings may be prepared for discussion. These may be made quickly by means of rough drawings or freehand sketches on plain paper.

The use of squared or isometric backing paper can facilitate the preparation of rough and freehand sketches.

6.5 Projections

Wherever possible, all views should be of the Third Angle Projection, and ample space shall be left between the views in order to avoid crowding of dimensions and notes. Any view not of the Third Angle Projection shall be indicated by a note "View in Direction of Arrow A" or other suitable designation. Sectional views shall be indicated by a note, such as "Section AA" and the plan of the section clearly shown.

7. LINE CONVENTIONS

These describe the size, construction, and applications of the various lines used in making engineering drawings.

7.1 Line Widths

Two widths of lines, as shown in Fig. 1, are recommended for use on manually prepared drawings. One width of line is acceptable on drawings prepared mechanically and on undimensioned drawings. The ratio of line thicknesses should be approximately two-to-one. It is recommended that the thinline width be approximately 0.35 mm and the thick-line width be approximately 0.7 mm.

The actual width of each line shall be governed by the size and style of the drawing, and the smallest size to which it is to be reduced. All lines of the same type should be uniform throughout the drawing. Spacing between parallel lines should be such that there is no fill-in when reproduced by available photographic methods.

Note:

Spacing of no less than 1.5 mm normally meets reproduction requirements.

7.1.1 All lines should be clean-cut, opaque, uniform, and properly spaced for legible reproduction by all commonly used methods, including microfilming.

7.2 Center Lines

Center lines shall project for a short distance beyond the outline to which they refer, but they may be extended where necessary to aid dimensioning or to corelate views.

7.3 Line Standards

The following list gives a series of line thickness standards for pencil and ink work.

	Pencil Work	Ink Work
For extra stress	0.9 mm. H heavy pressure	1.0 mm.
For general work	0.7 mm. H heavy pressure	0.4 mm.
For background	0.5 mm. H heavy pressure	0.2 mm.
For dimensions, etc.	0.5 mm. H light pressure	0.2 mm.

When drawings require less than four thicknesses, the heavier lines in the Standard shall be used.

8. LETTERING

This identifies the type and style of lettering for use on engineering drawings.

8.1 Single-Stroke Gothic Lettering

Lettering on drawings must be legible and suitable for easy and rapid execution. These requirements are met in the recommended single-stroke gothic characters shown in Figs. 2 and 3 or adaptations there of, which improve reproduction legibility.

8.1.1 Either inclined or vertical lettering is permissible. Only one style of lettering should be used throughout a drawing. The preferred slope for the inclined characters is 2 in 5 or approximately 68 degrees with the horizontal. See Fig. 2.

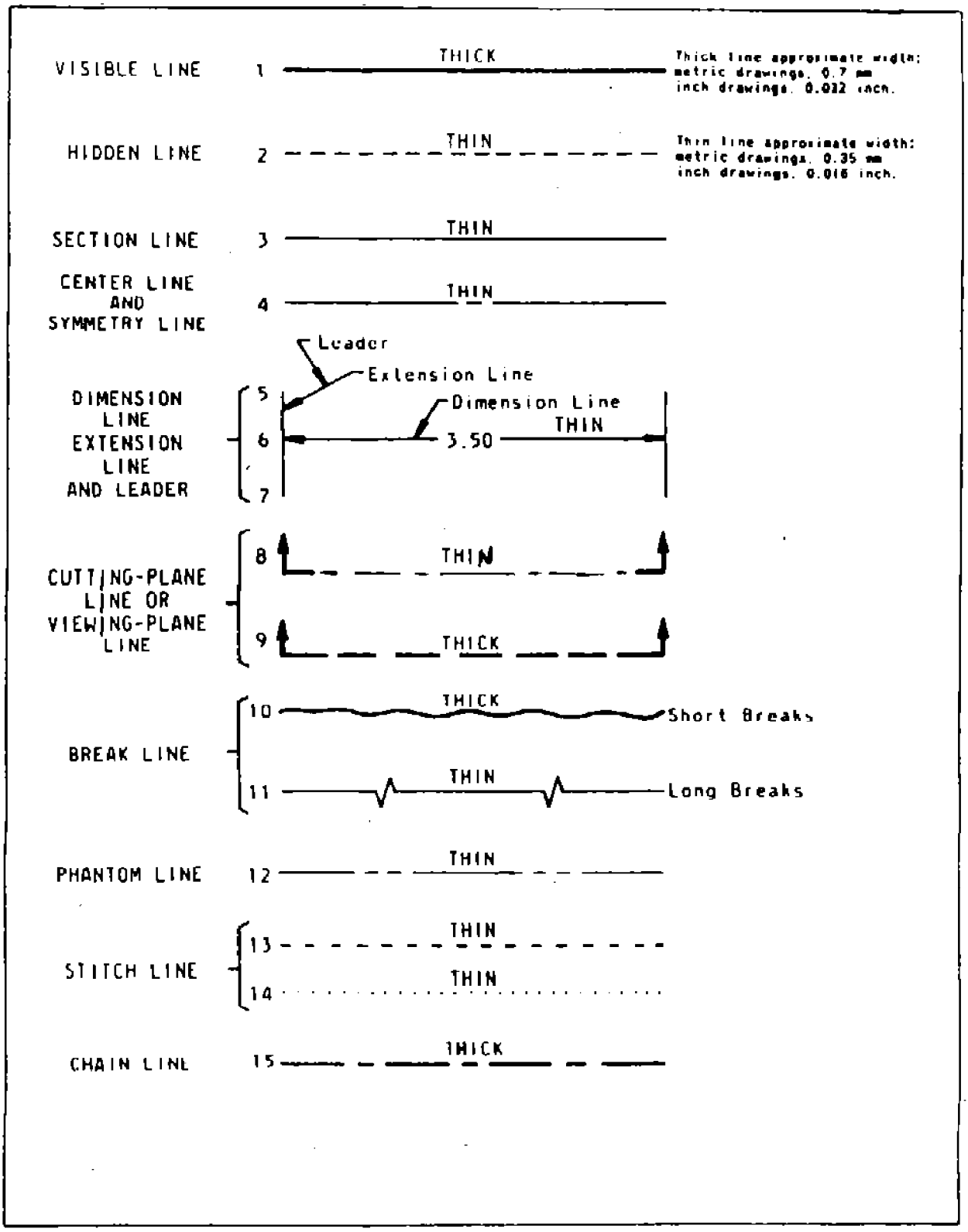
8.1.2 Upper case letters shall be used for all lettering on drawings unless lower case letters are required to conform with other established standards, equipment nomenclature or marking. See Figs. 2 and 3. When additions or revisions are made, the original style of lettering should be maintained.

8.1.3 Lettering of titles, subtitles, drawing numbers, and other uses may be made freehand, by Auto Cad typewriter, or with the aid of mechanical lettering devices such as templates and lettering machines. Regardless of the method used, all characters are to conform, in general, with the recommended gothic style and must be legible in full or reduced size copy by any accepted method of reproduction.

8.1.4 Letters in words should be spaced so that the background areas between the letters are approximately equal, and words are to be clearly separated by a space equal to the height of the lettering. A space between letters of at least 1.5 mm is recommended. The space between two numerals having a decimal point between them is to be a minimum of two thirds the height of the lettering. Sentences should be separated horizontally by a space equal to twice the height of the lettering. The vertical space between lines of lettering should be no more than the height of the lettering, and no less than half the height of the lettering.

8.1.5 Notes should be placed horizontally on drawings and separated vertically by spaces at least equal to double the height of the character size used, to maintain the identity of each note.

8.1.6 Lettering should not be underlined except when special emphasis is required. The underlining should not be less than 1.5 mm below the lettering.



WIDTH AND TYPE OF LINES
Fig. 1

INCLINED LETTERS
Fig. 2

VERTICAL LETTERS
Fig. 3

9. DIMENSIONING

9.1 Application

9.1.1 All dimensional information necessary to define a part or component clearly and completely shall be shown directly on a drawing unless this information is specified in associated documentation.

9.1.2 Each feature shall be dimensioned once only on a drawing.

9.1.3 Dimensions shall be placed on the view or section that most clearly shows the corresponding features.

9.1.4 Each drawing shall use the same unit (for example, millimetres) for all dimensions but without showing the unit symbol. In order to avoid misinterpretation, the predominant unit symbol on a drawing may be specified in a note.

Where other units have to be shown as part of the drawing specification (for example, N., for torque or kPa for pressure), the appropriate unit symbol shall be shown with the value.

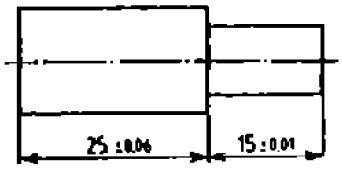
9.1.5 No more dimensions than are necessary to define a part or an end product shall be shown on a drawing. No feature of a part or an end product shall be defined by more than one dimension in any one direction. Exception may, however, be made:

a) where it is necessary to give additional dimensions at intermediate stages of production (for example, the size of a feature prior to carburizing and finishing);

b) where the addition of an auxiliary dimension would be advantageous.

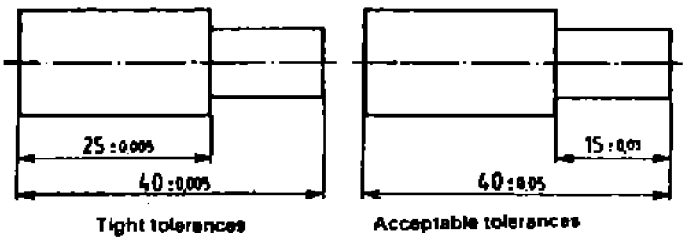
9.1.6 Production processes or inspection methods should not be specified unless they are essential to ensure satisfactory functioning or interchangeability.

9.1.7 Functional dimensions should be shown directly on the drawing wherever possible (see Fig. 4).



FUNCTIONAL DIMENSIONING
Fig. 4

Occasionally indirect functional dimensioning is justified or necessary. In such cases, care shall be exercised so that the effect of directly shown functional dimensioning is maintained. Fig. 5 shows the effect of acceptable indirect functional dimensioning that maintains the dimensional requirements established by Fig. 4.



INDIRECT FUNCTIONAL DIMENSIONING
Fig. 5

9.1.8 The non-functional dimensions should be placed in a way which is most convenient for production and inspection.

9.2 Elements of Dimensioning

The elements of dimensioning include the projection line, dimension line, leader line, dimension line termination, the origin indication, and the dimension itself. The various elements of dimensioning are illustrated in Figs. 6 and 7.

9.3 Projection Lines, Dimension Lines and Leader Lines

Projection lines, dimension lines and leader lines are drawn as thin continuous lines as shown and as illustrated in Figs. 6 and 7.

9.3.1 Projection lines shall extend slightly beyond the respective dimension line (see Figs. 6 and 7).

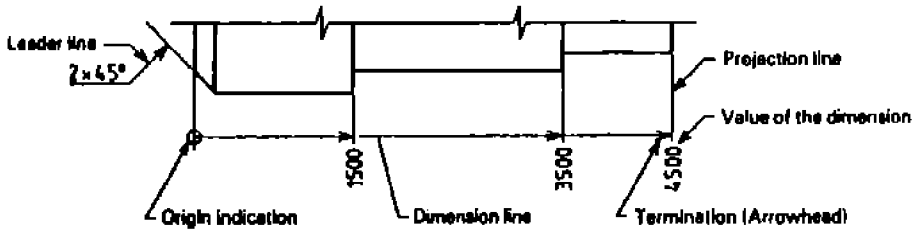


Fig. 6

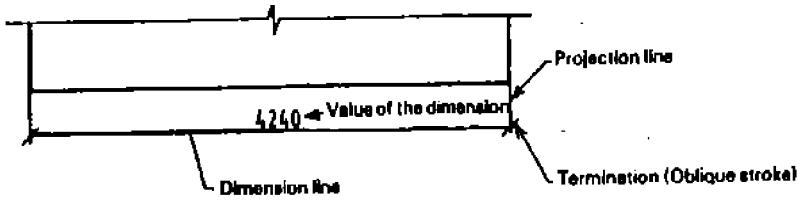


Fig. 7

9.3.2 Projection lines should be drawn perpendicular to the feature being dimensioned. Where necessary, however, they may be drawn obliquely, but parallel to each other (see Fig. 8).

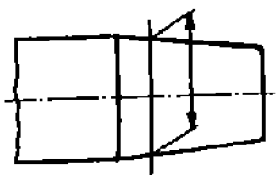


Fig. 8

9.3.3 Intersecting construction and projection lines shall extend slightly beyond their point of intersection (see Fig. 9).

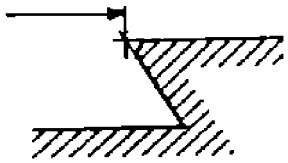


Fig. 9

9.3.4 In general, projection lines and dimension lines should not cross other lines unless this is unavoidable (see Fig. 10).

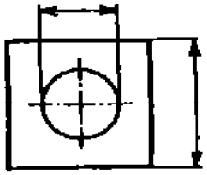


Fig. 10

9.3.5 A dimension line shall be shown unbroken where the feature to which it refers is shown broken (see Fig. 11, except as indicated in 10.5.1, method 2).

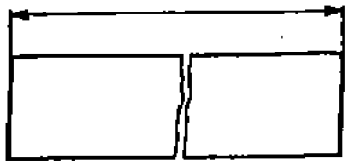


Fig. 11

9.3.6 Intersecting projection and dimension lines should be avoided. Where unavoidable, however, neither line shall be shown with a break (see Fig. 12).

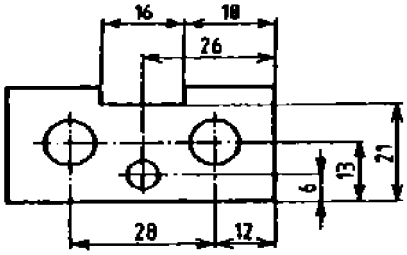


Fig. 12

9.3.7 A centreline or the outline of a part shall not be used as a dimension line but may be used in place of a projection line (see Fig. 12).

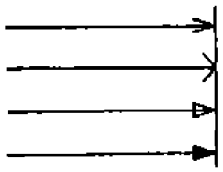
9.4 Terminations and Origin Indication

Dimension lines shall show distinct terminations (i.e., either arrowheads or oblique strokes), or, where applicable, an origin indication.

9.4.1 Two dimension line terminations (see Fig. 13) and an origin indication (see Fig. 14) are specified in this standard. They are:

a) The arrowhead, drawn as short lines forming barbs at any convenient included angle between 15° and 90°. The arrowhead may be open, closed, or closed and filled in (see Fig. 13 a).

b) The oblique stroke, drawn as a short line inclined at 45° (see Fig. 13 b).



a) Arrowheads

b) Oblique stroke

Fig. 13

c) The origin indication, drawn as a small open circle of approximately 3 mm in diameter. (See Fig. 14)

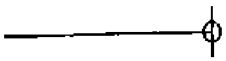


Fig. 14

9.4.2 The size of the terminations shall be proportionate to the size of drawing on which they are used but not larger than is necessary to read the drawing.

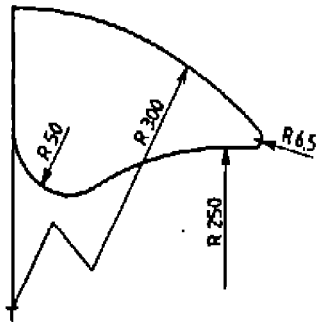
9.4.3 One style of arrowhead termination only shall be used on a single drawing. However, where space is too small for an arrowhead, the oblique stroke or a dot may be substituted (see Fig. 26).

9.4.4 Arrowhead terminations shall be shown within the limits of the dimension line where space is available (see Fig. 15). Where space is limited, the arrowhead termination may be shown outside the intended limits of the dimension line that is extended for that purpose (see Fig. 16).

Fig. 15

Fig. 16

9.4.5 Only one arrowhead termination, with its point on the arc end of the dimension line, shall be used where a radius is dimensioned (see Fig. 17). The arrowhead termination may be either on the inside or on the outside of the feature outline (or its projection line) depending upon the size of the feature.



RADIUS DIMENSIONING
Fig. 17

9.5 Indicating Dimensional Values on Drawings

Dimensional values shall be shown on drawings in characters of sufficient size to ensure complete legibility on the original drawing as well as on reproductions made from microfilms.

They shall be placed in such a way that they are not crossed or separated by any other line on the drawing.

9.5.1 Values shall be indicated on a drawing according to one of the following two methods. Only one method should be used on any one drawing.

Method 1

Dimensional values shall be placed parallel to their dimension lines and preferably near the middle, above and clear of the dimension line (see Fig. 18).

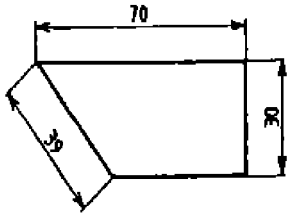


Fig. 18

However, values shall be indicated so that they can be read from the bottom or from the right-hand side of the drawing . Values on oblique dimension lines shall be oriented as shown in Fig. 19.

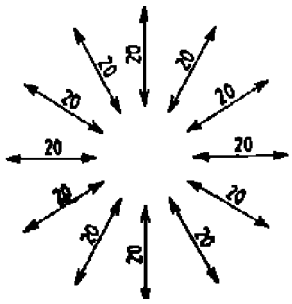


Fig. 19

Angular dimensional values may be oriented either as in Fig. 20 or Fig. 21.

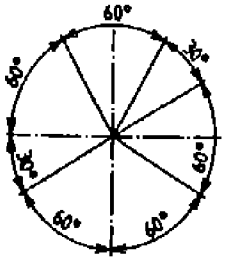


Fig. 20

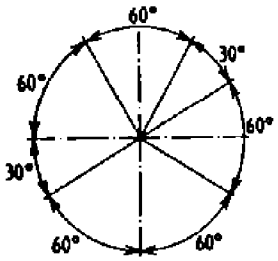


Fig. 21

Method 2

Dimensional values shall be indicated so that they can be read from the bottom of the drawing sheet. Non-horizontal dimension lines are interrupted, preferably near the middle so that the value can be inserted (see Figs. 22 and 23).

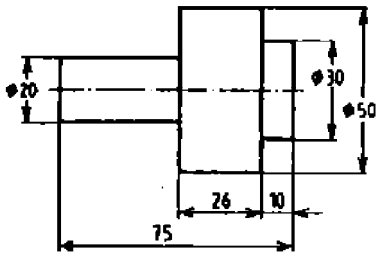


Fig. 22

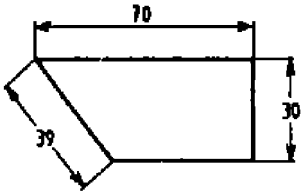


Fig. 23

Angular dimensional values may be oriented either as in Fig. 21 or Fig. 24.

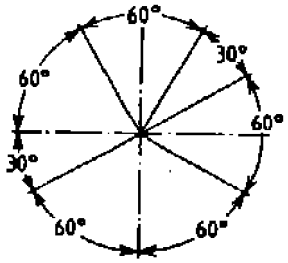


Fig. 24

9.5.2 The positioning of dimensional values frequently needs adapting to different situations. Therefore, for example, values can be:

a) Closer to a termination to avoid having to follow a long dimension line where only part of the dimension line needs to be shown (see Fig. 25).

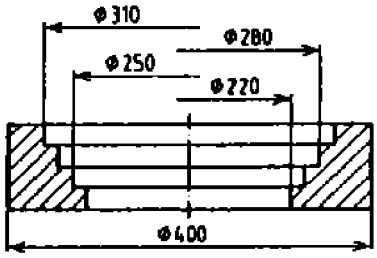


Fig. 25

b) Above the extension of the dimension line beyond one of the terminations if space is limited (see Fig. 26).

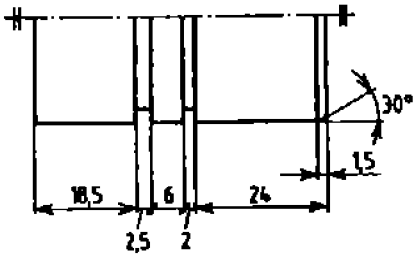


Fig. 26

c) At the end of a leader line which terminates on a dimension line that is too short for the dimensional value to be indicated in the usual way (see Fig. 26).

d) Above a horizontal extension of a dimension line where space does not allow placement at the interruption of a non-horizontal dimension line (see Fig. 27).

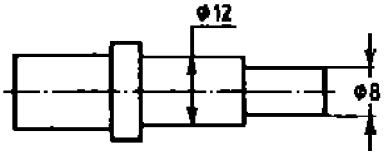


Fig. 27

9.5.3 Values for dimensions out-of-scale (except where break lines are used) shall be underlined with a straight thick line (see Fig. 28).

Note:

Dimensions out-of-scale can result from a feature size modification where the modification does not warrant an extensive drawing revision to correct the feature scale.

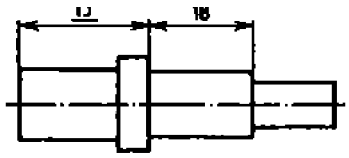


Fig. 28

9.5.4 The following indications are used with dimensions to show applicable shape identification and to improve drawing interpretation. The diameter and square symbols may be omitted where the shape is clearly indicated. The applicable indication (symbol shall precede the value for the dimension (see Figs. 29 to 33)).

ϕ	:	Diameter	SR:	Spherical radius
R	:	Radius	Sϕ:	Spherical diameter
b	:	Square		

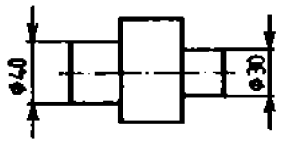


Fig. 29

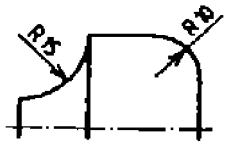


Fig. 30

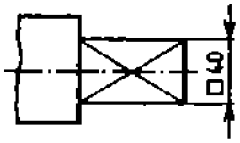


Fig. 31

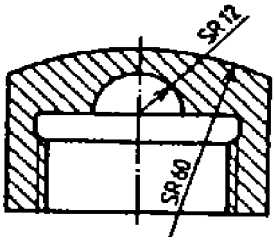


Fig. 32

9.6 Completeness

9.6.1 General

Sufficient dimensions shall be included to permit the shop or field to fabricate or install the equipment. In particular, the dimensions on a drawing shall be complete enough when added to the information on the reference drawings listed (such as manufacturers drawings and piping detail sheets) to permit anyone to check the drawing.

9.6.2 Piping

Most piping jobs can be shown by layout or assembly drawing and individual piping detail sheets.

9.7 Placing of Dimensions on Drawings

Whenever possible, dimensions and sizes should be printed in a clear space on the drawing and not written inside the working lines of equipment or parts.

9.8 Completeness of Dimensions

Sometimes it will be more practical to give only approximate dimensions such as on the last piping detail which connects into existing piping or on changes of direction or elevation to existing supports, etc. In such cases all the piping details other than the closing spools should be fully dimensioned. The closing spools can be approximately dimensioned (including enough pipe to allow for trimming) and a notation added such as "Loose Flange" or "Palin End" (P.E.) instead of the usual "Beveled End"(B.E.) for welding.

10. DETAIL DRAUGHTING

10.1 Often a design feature on drawing will be shown by a detail drawn to larger scale. In such cases the location of the detail shall be referred to by a note such as "See Detail A" The caption to the actual detail shall include the same letter. e.g. Detail "A " , 6 " Inlet Nozzle. The scale used for each detail shall be indicated below the caption for that detail.

10.2 Unnecessary Detail

Often an outline of available equipment is included on a layout drawing for background illustration. This sometimes includes pumps, structures, building floor plans etc. In such cases a bare minimum of outline shall be shown including no details. Bare minimum should include steel members of buildings, doors, windows etc. For a pump a box which would include the extremities of the casing and showing flange connections would suffice without showing the actual true outline of pump, bolting, coupling, motor, etc.

A key plan should be shown on Architectural and Civil Drawings in the top R.H. Drawing area.

10.3 Valves

Piping drawings shall indicate handwheel positions or orientations in at least one appropriate view.

10.4 Gaskets

An allowance for gaskets shall be made in piping work and shall be taken into consideration in making up detail sheets. The gasket thickness shall be indicated by a general note on the drawing.

11. GENERAL NOTES & REFERENCES

11.1 General Notes

11.1.1 Notes shall be given in the order in which, for swift and accurate appraisal, they should be read.

If events have a chronological sequence, the notes must be given in that sequence:

e.g. "1. Check the excavation levels given."
"2. Bottom of excavation is to be blinded with....," and not vice versa.

11.1.2 Exceptions to an instruction shall be given before the instruction:

e.g. "Except where noted all holes are 25 mm dia" and not "All holes are 25 mm dia except where noted.

11.1.3 Qualifying clauses shall be given first:

e.g. "Tanks 27 to 30 only inlet nozzles are now 8" dia." and not "Inlet nozzles are now 8" dia for tanks 27 to 30 only."

11.1.4 A general note applies to several details on a drawing or the entire drawing. General notes shall be numbered.

11.2 References Drawings

11.2.1 All main layout drawings shall include a list of pertinent reference drawings including Manufacturers Drawings, Standard Drawings, Pipe Detail Sheets, P & I diagrams and Material Take-off Sheets. The list of reference drawings shall include all drawings necessary for construction.

11.2.2 Matching drawing numbers and reference drawing numbers may have to be included elsewhere in the drawing at matchlines and in the appropriate views or sections, but they should still be included in the reference drawing table.

Detail drawings in general shall list as reference drawings only the main layout drawing and drawings pertaining directly to the detail shown.

11.2.3 Standard drawings

Whenever possible, standard. drawings shall be used rather than specially designed details. Standard drawings will not be copied on layout drawings but shall be referred to and listed as reference drawings.

12. DRAWING ORIENTATION

Survey and layout drawings shall be made with the true or plant north to the top of the sheet, if this is not possible then to the left of the sheet. All plans made for one job shall have the same orientation, i.e. north to the top or to the left of the sheets. Except in the case of standard drawings where orientations may differ in use.

The north arrow shall take the form shown overleaf.

Double arrows giving the relationship between true and plant norths shall be shown on surveys and site plans only.

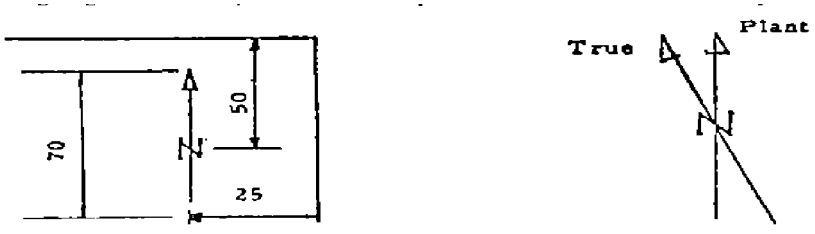


Fig. 33

13. MATERIAL

13.1 Maximum use shall be made of an item numbering system whereby all items of material and equipment, incorporated in design and shown on the relevant drawings, shall be given an item number on the drawing. This item number shall be encircled and shall indicate the appropriate item, or identical items bearing the same number. Any particular item, which is shown either in more than one elevation, or on more than one drawing, shall be numbered on one drawing and on one elevation only. The number should be used as an item number on the associated Material Take-off sheet.

13.2 Special piping assemblies which are identified by a spool number e.g. G-6"-1 and thus scheduled for fabrication, shall be classed as one item.

13.3 A description of all materials used on the drawing, and alloted a part number or a spool number shall be given on the Material Take-Off Sheet (Appendix 1) against the identifying part number indicating also quantity and Indent Number. The description on the Material Take-Off Sheets for special piping assemblies shall refer to the piping detail sheet only, (Appendix 2). A summary of Material for Pipe Spool Sheets should be prepared in respect of all Pipe Spools which are to be fabricated in Refinery Workshops (Appendix 3).

13.4 When necessary, consideration should be given to the inclusion of a brief description of selected items of equipment in the upper right hand corner of drawing to enable the reader to get a general idea of the type and quality of construction materials used without having to refer to Material Take-Off Sheets.

13.5 Identification of Materials

Recommended methods of indicating materials by hatching as per BS 1192 will be used. Where any confusion is likely to occur in the interpretation of symbols, a legend or key should be shown.

14. MATERIAL TAKE-OFF

14.1 A Material Take-Off Sheet (Appendix 1) shall be compiled for any drawing where material is involved.

14.2 The Material Take-Off will list the tag numbers (which have been given on the drawing), a material description for each part number, the number required for the particular drawing, Ref. No of the Project Material Request in which the part is covered, and the item number of the request which includes this material.

14.3 When preparing Material Take-Off Sheets for main drawings, materials shown on any Standard Drawings referred to in the main drawing must be included.

15. SUMMARY OF MATERIAL FOR PIPE SPOOLS

When a drawing involves piping, piping detail sheets (or spool sheets) will be produced for the pipe spools pertaining to that drawing. Each spool sheet will list the material required for the spool it depicts, and a final summary of material for pipe spools will be compiled for each drawing comprising the summation of all the materials listed on all the spool sheets for that drawing. This information will finally be transferred to the Material Take-Off (Sheet(s) for the drawing and comprise the total requirement for fabricated piping material for the Darwing. See Appendix 2.

15.1 Identical items from Material Take-Off Sheets will be collected and consolidated under single item numbers on the Project Material Request.

15.2 For detailed instructions for preparing Project Materials Requests, refer to the relevant Procedures Manual.

16. TOLERATING

16.1 Tolerating of Linear and Angular Dimensions

16.1.1 Units

Deviations shall be expressed in the same unit as the basic size.

If two deviations relating to the same dimension have to be shown, both shall be expressed to the same number of decimal places (see Fig. 34), except if one of the deviations is zero (see Fig. 36).

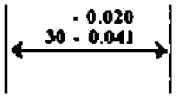


Fig. 34

16.1.2 Permissible deviations

The components of the toleranced dimension shall be indicated in the following order (see Fig. 35 to 37):

a) the basic size;
b) the values of the deviations.

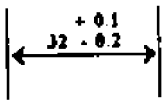


Fig. 35

If one of the two deviations is zero , this should be expressed by the digit zero (see Fig. 36).

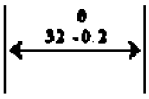


Fig. 36

If the tolerance is symmetrical in relation to the basic size, the value of the deviations should be indicated once only, preceded by the sign ± (see Fig. 37).

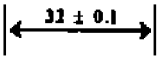


Fig. 37

16.1.3 Limits of size

The limits of size may be indicated by an upper and lower dimension (see Fig. 38).

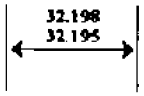


Fig. 38

16.1.4 Limits of size in one direction

If a dimension needs to be limited in one direction only, this should be indicated by adding "min.". or "max." to the dimension (see Fig. 39).

Fig. 39

16.1.5 Order of indication of deviations and limits of sizeThe upper deviation or the upper limit of size shall be written in the upper position and the lower deviation or the lower limit of size in the lower position, irrespective of whether a hole or a shaft is toleranced.

16.1.6 Indication of tolerances on drawings of assembled parts

16.1.6.1 Values by digits

The dimension for each of the components of the assembled parts shall be preceded by the name (see Fig. 40) or item reference (see Fig . 41) of the components, the dimension for the hole being placed in both cases above that for the shaft.

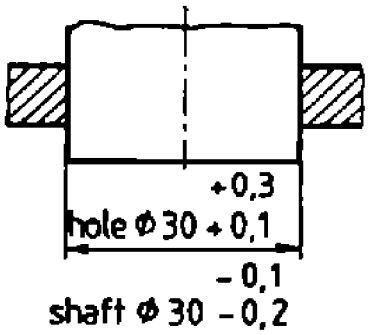


Fig. 40

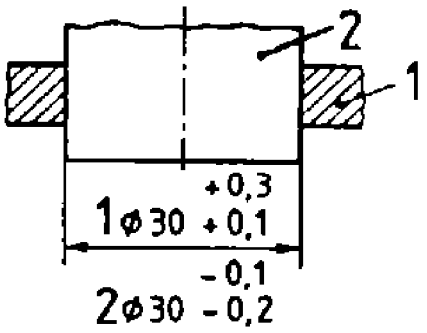


Fig. 41

16.1.7 Indication of the components of an angular dimension

The rules given for the indication of tolerances on linear dimensions are equally applicable to angular dimensions, except that the units of the basic angle and the fractions thereof, as well as the deviations, shall always be indicated (see Fig. 42 to 45). If the angular deviation is expressed in either minutes of a degree or seconds of a minute of degree, the value of the minute or second shall be preceded by 0° or 0°0', as applicable.

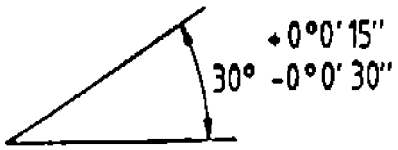


Fig. 42

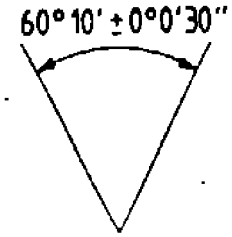


Fig. 43

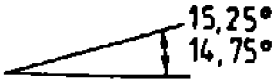


Fig. 44

Fig. 45

17. SCALES

17.1 The recommended scales for use on technical drawings are specified in the following table.

CATEGORY	RECOMMENDED SCALES		
Reduction Scales	1:2 1:20 1:200 1:2000	1:5 1:50 1:500 1:5,000	1:10 1:100 1:1000 1:10,000
Full size			
Enlargement Scales	50:1 5:1	20:1 2:1	10:1

LAYOUT PLANS & MAPS SCALES	
1:200	1:500
1:1000	1:2500
1:5000	1:10000
1:25000	1:50000
1:100000	1:250000
1:500000	1:1000000
1:250000	1:5000000

17.2 If, for special applications, there is need for a larger enlargement scale or a smaller reduction scale than those shown in the table, the recommended range of scales may be extended in either direction, provided that the required scale be derived from a recommended scale by multiplying by whole number powers of 10. In exceptional cases where for functional reasons the recommended scales cannot be applied, intermediate scales may be chosen.

17.3 The scale to be chosen for a drawing will depend upon the complexity of the object to be depicted and the purpose of the representation.

In all cases, the selected scale shall be large enough to permit easy and clear interpretation of the information depicted.

The scale and the size of the object, in turn, will decide the size of the drawing.

17.4 Details that are too small for complete dimensioning in the main representation shall be shown adjacent to the main representation in a separate detail view (or section) which is drawn to a larger scale.

17.5 For information, a full size view be added to the large scale representation of small object. In this case the full size view may be simplified by showing the outlines of the object only.

18. SURFACE TEXTURE SYMBOL

The surface texture symbols shall be accordance with ANSI Y 14.36 (1978).

19. MULTI AND SECTIONAL VIEW DRAWINGS

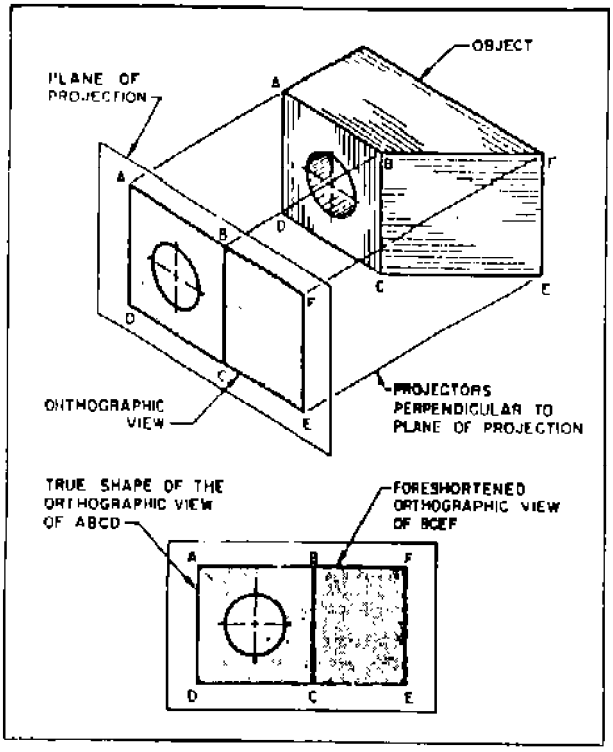
19.1 The Multiview System of Orthographic Drawings

19.1.1 Orthographic projection

A system of drawing composed of images of an object formed by projectors from the object perpendicular to desired planes of projection.

19.1.2 Orthographic view

The figure outlined upon the projection plane by means of the system of orthographic projection. Such a view shows the true size and shape of a surface parallel to the projection plane (area ABCD with hole in Fig. 46). If an area is not parallel to the plane, the view of the area will be foreshortened (area BCEF in Fig. 46).



ORTHOGRAPHIC PROJECTION TO FORM AN ORTHOGRAPHIC VIEW
Fig. 46

19.1.3 Projection Systems

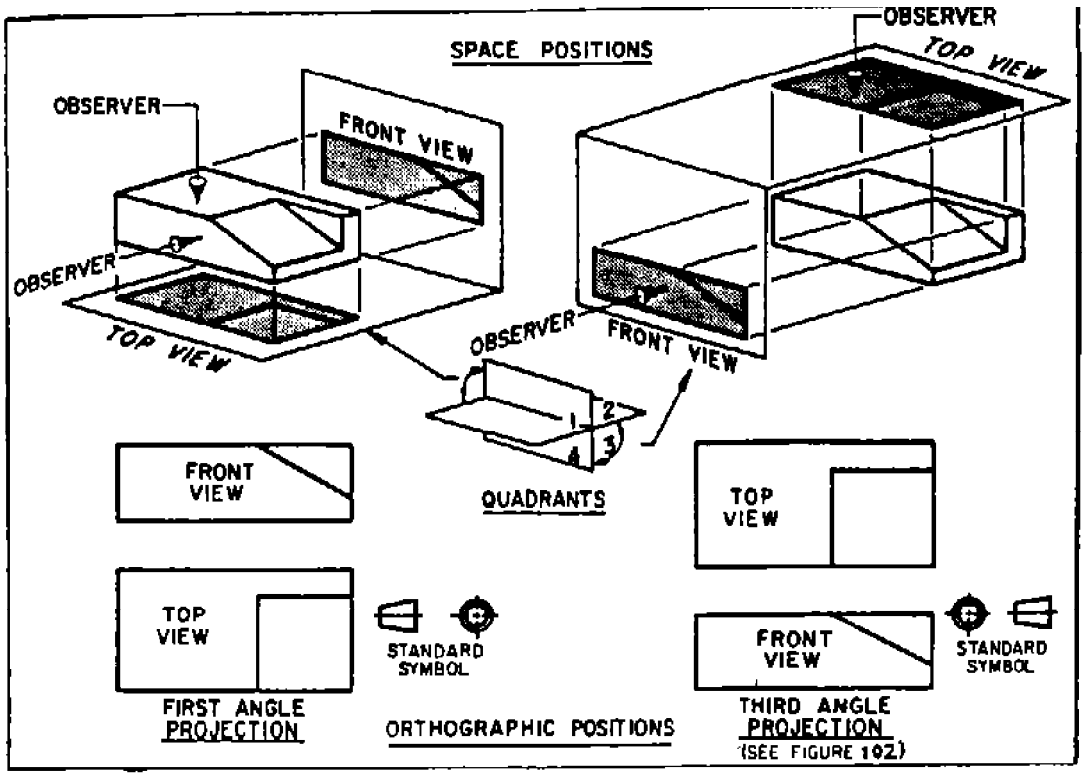
Two system of projections are recognized namely third angle projection and first angle projection . The last system is recommended.

19.1.3.1 Third angle projection is the formation of an image or view upon a plane of projection placed between the object and the observer. Third angle projection is the accepted method used in the united states. See Fig. 47.

19.1.3.2 First angle projection places the object between the observer and the plane of projection.

This method of projection, the commonly accepted method is described herein in consideration of the international interchange of engineering drawings. See Fig. 47.

19.1.3.3 Note that the orthographic views of the object have the same configuration in both the first and third angle projections, but the placement of the views with respect to one another is different. The visibility of lines is always taken from the observer's point of view. See Figs. 47 and 48.



SPACE AND ORTHOGRAPHIC ARRANGEMENT OF VIEWS (FIRST AND THIRD ANGLE PROJECTION)
Fig. 47

19.1.3.4 The small symbols on the drawings in Fig. 47 and 48 are the internationally recognized projection symbols. They are used on drawings to be interchanged internationally.

19.1.4 Principal views

There are six principal views; top, front, bottom, right side,left side, and rear. The standard arrangement of all principal views in third angle projection is shown in Fig. 48. Alternate positions of views may be made to conserve space, but they should be properly oriented to each other. For example, the right or left side might be placed adjacent to and in alignment with the top view. The rear view is sometimes placed in alignment with and to the right of the right side view.

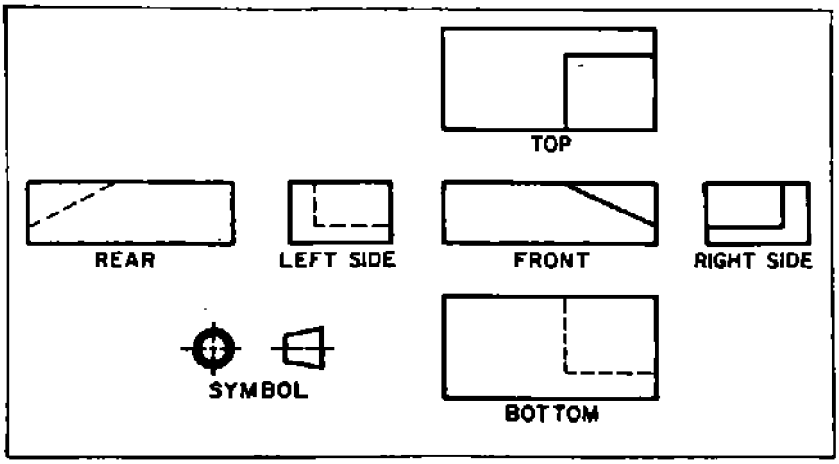
Notes:

1) Adjacent views

Two adjoining orthographic views aligned by projection lines.

2) Related views

Two views which are adjacent to the same intermediate view.



THE SIX PRINCIPAL ORTHOGRAPHIC VIEWS
(STANDARD ARRANGEMENT-THIRD ANGLE)
Fig. 48

20. PICTORIAL DRAWING

20.1 General

This clause has been prepared for the purpose of defining and illustrating the various kinds of pictorial drawings, with such additional information as may be necessary in the use of these drawings in industry.

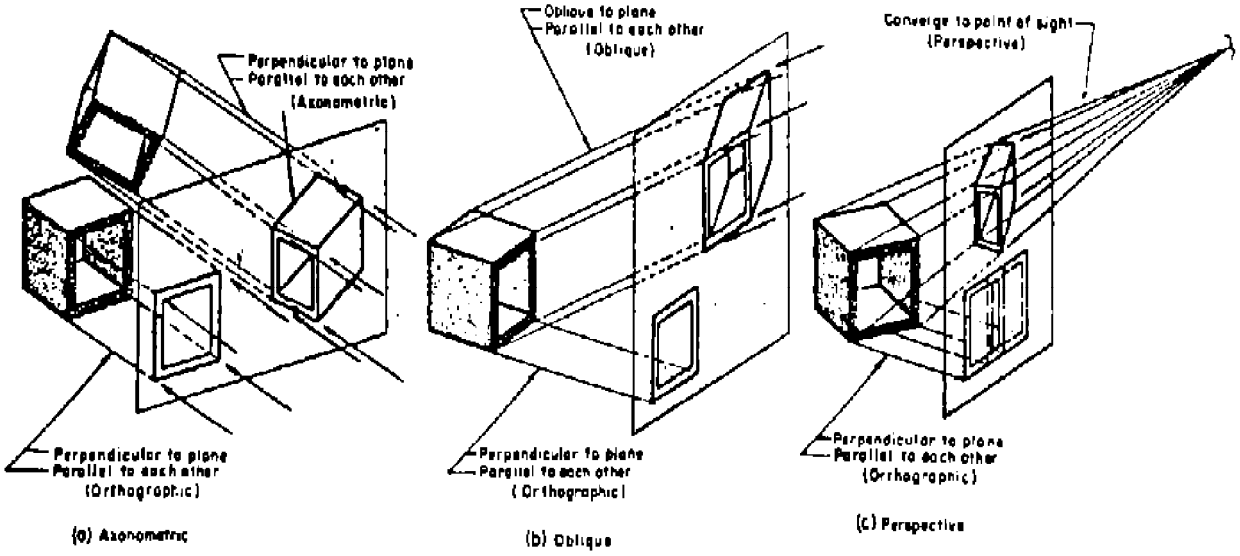
20.2 Uses of Pictorial Drawing

Pictorial drawing is the oldest written method of communication known to man, but the character of pictorial drawing has continually changed with the advance of civilization. In this standard those kinds of pictorial drawings commonly used by the engineer and his associates are to be considered. Pictorial drawings are useful in design, in construction or production, erection or assembly, service or repairs, and in sales. They are used to explain complicated engineering drawings to people who do not have the ability or time to read the conventional multiview drawings; to help the designer work out his problems in space, including clearances and interferences; to train new employers in the shop; to speed up and clarify the assembling of a machine or the ordering of new parts; to transmit ideas from one person to another, from shop to shop, or from salesman to purchaser, and as an aid in developing the power of visualization.

The kind of pictorial drawing used depends on the purpose for which it is drawn.

20.3 Kinds of Pictorial Drawing

There are three general groups into which pictorial drawings may be divided: axonometric, oblique, and perspective. These three differ from each other in the fundamental scheme of projection, as shown in Fig. 49. This Fig. also shows a front view in each case for comparison, and brings out the fact that axonometric projection is a form of orthographic projection. Each of these groups is then further subdivided by varying some of the relationships between point of sight, plane of projection, and object.



KINDS OF PROJECTION
Fig. 49

20.3.1 Axonometric

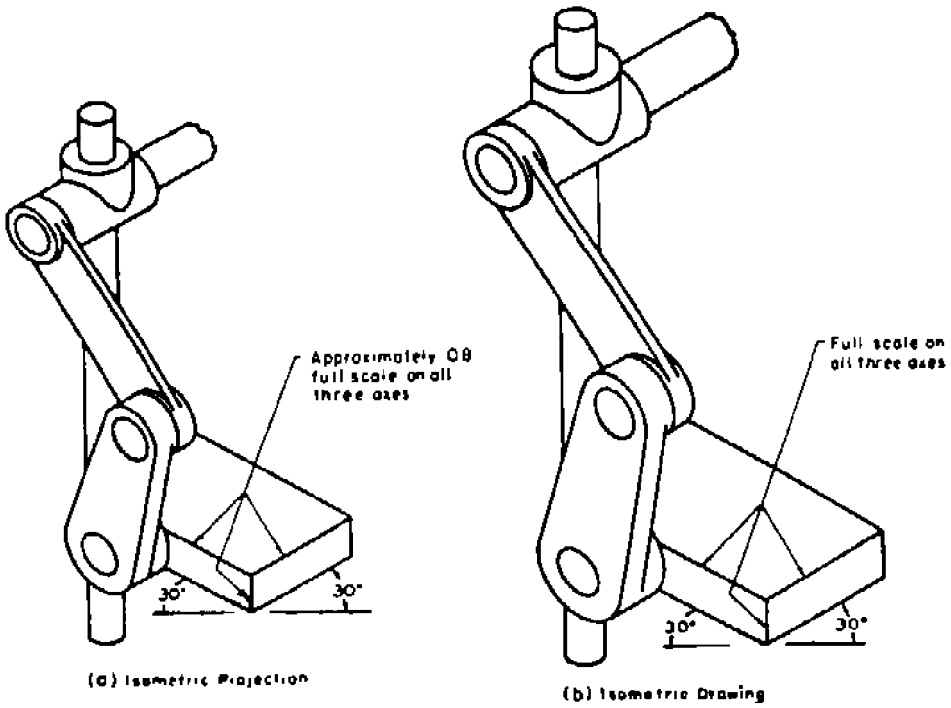
A projected view in which the lines of sight are perpendicular to the plane of projection, but in which the three faces of a rectangular object are all inclined to the plane of projection is called an axonometric projection. The projections of the three principal axes may make any angle with each other except 90°. A circle will project as an ellipse whose major axis must be perpendicular to the axis of the right circular cylinder of which the circle is one base. This is illustrated in Figures to. The view of the object should be so chosen that it will give the most information possible unless other considerations such as natural position or relation or other objects must take precedence.

20.3.1.1 Isometric

A pictorial drawing in which the three principal faces and the three principal axes of the object are equally inclined to the plane of projection, which is called the isometric plane, is an isometric. The three axes on the drawing also make equal angles with each other, but may be placed in a variety of positions.

20.3.1.1.1 Isometric projection

A true orthographic projection of an object on the isometric plane is called an isometric projection. The scales on all three axes are equal and foreshortened in the ratio of approximately 0.8 to 1.0. See Fig. 50 (a). The term axes refers to the projections of the principal axes unless otherwise stated.



ISOMETRIC
Fig. 50

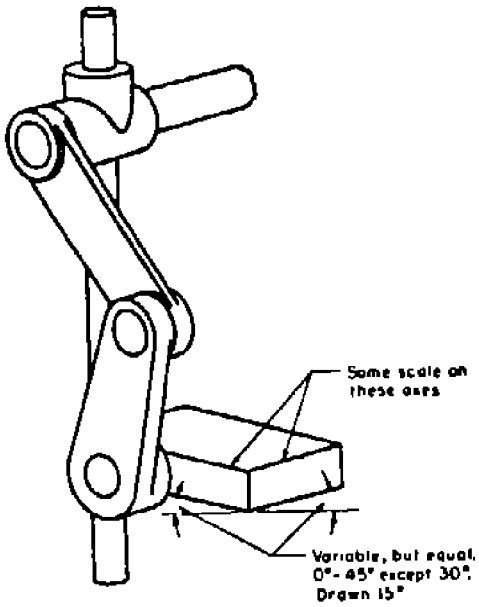
20.3.1.1.2 Isometric drawing

A pictorial drawing resembling an isometric projection in that the three axes make equal angles (120°) with each other is called an isometric drawing. The distances on each axis are measured in true length with any standard scale, thus making a drawing larger than isometric projection. See Fig. 50 (b). This is the form in which isometric is most commonly used.

20.3.1.2 Dimetric

An axonometric projection in which two sides and two of the axes of a rectangular object make equal angles with the plane of the projection, while the third face and the third axis make a different angle is called dimetric projection. See Fig. 51. Two of the angles on the drawing, between the axes are equal but the third is different. A variety of positions of the axes may be used.

Under certain conditions a dimetric may be constructed conveniently by scaling along the axes using two different scales. These scales change whenever the angles of the axes change.

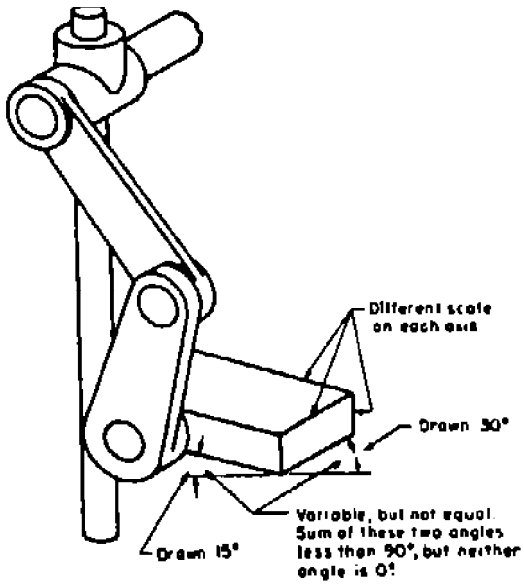


DIMETRIC PROJECTION
Fig. 51

20.3.1.3 Trimetric

An axonometric projection in which all three faces and three axes of a rectangular object make different angles with the plane of projection is called trimetric projection. See Fig. 52. The angles on the drawing between the axes are all different. They may be placed in a variety of positions.

Under certain conditions a trimetric may be constructed conveniently by scaling along the three axes using three different scales. These scales change whenever the angles of the axes change.



TRIMETRIC PROJECTION
Fig. 52

20.4 Weight of Lines

The weight of lines shall be governed by the size and character of the drawing. The standard weights of lines as given for conventional engineering drawings should be used. Hidden lines are seldom shown, but if necessary, they should be drawn as in conventional multiview drawings. When an overall rendering is used, the lines may be omitted entirely. Both cases are shown in Fig. 53.

20.5 Break Lines

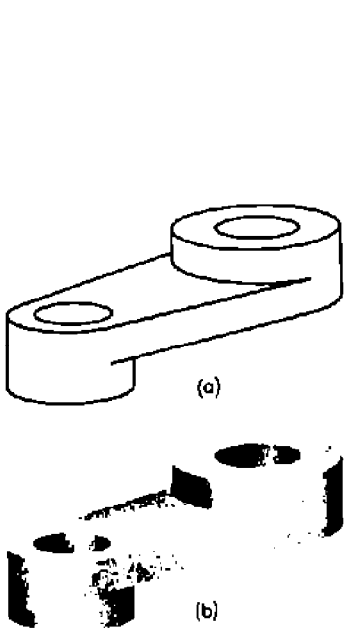
For long parts, break lines may be used to shorten the length of the drawing. Free-hand breaks are preferred as shown in Fig. 54.

20.6 Sectional Views

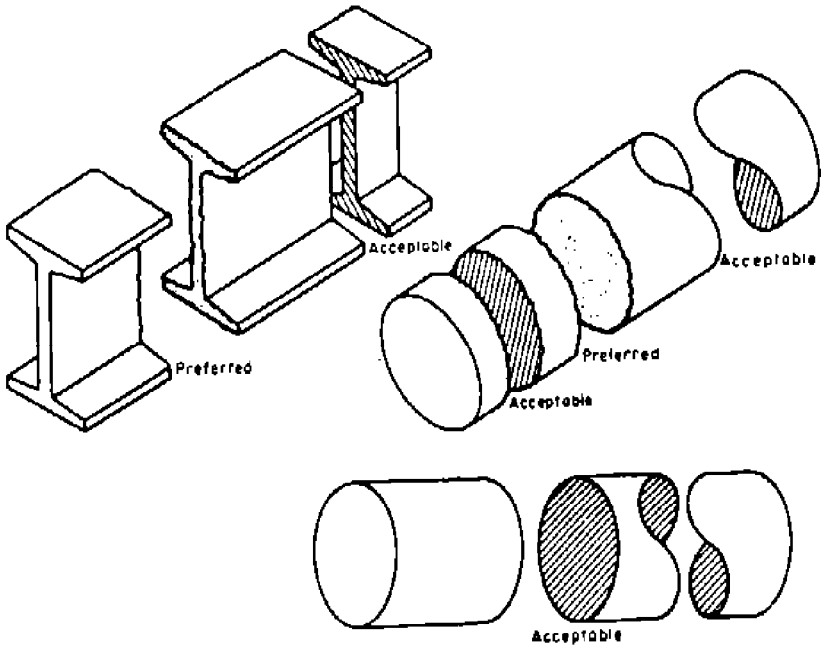
Section planes should pass through center lines and should be parallel to one of the principal faces of the object when possible. The pictorial should be arranged so the section plane is not shown edgewise. See Fig. 55.

20.6.1 Section lining

Standard weights of lines and spacing as well as standard symbols should be used.



USE OF LINES OR SHADING IN PICTORIAL
Fig. 53



BREAK LINES
Fig. 54

20.6.1.1 Assemblies

In assemblies, the various parts should be differentiated by using appropriate symbols and by changing the direction of the section lining.

20.6.1.2 Half section

Section lines in a half section should be drawn in such directions that they would appear to coincide if the planes were folded together as illustrated in Fig. 55 (a).

20.6.1.3 Full section

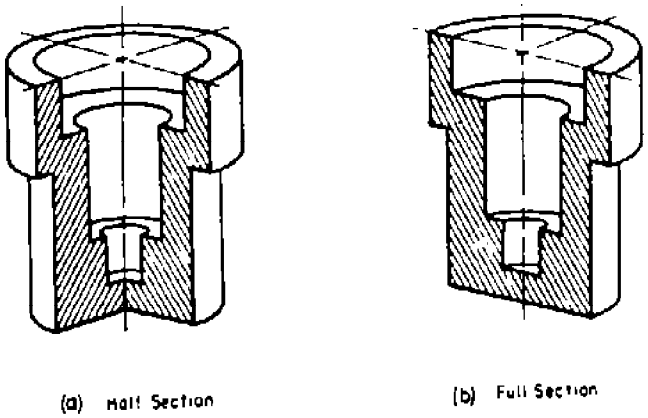
When a full section is used, the cross-hatching should all be drawn in the same direction as show in Fig. 55 (b).

20.6.1.4 Kinds of sections

Any of the standard kind of sections may be used in pictorial drawing.

20.6.1.5 Belts, shafts, keys, etc.

In assemblies, when a section plane would pass through shafts, bolts, keys, pins, etc., it is usually desirable to run the section around that unit and show the entire bolt or shaft in the pictorial. Except for such cases, the section lining should show exactly material has been cut. Fig. 56 shows a bolt, shaft, and key in the section of an assembly.

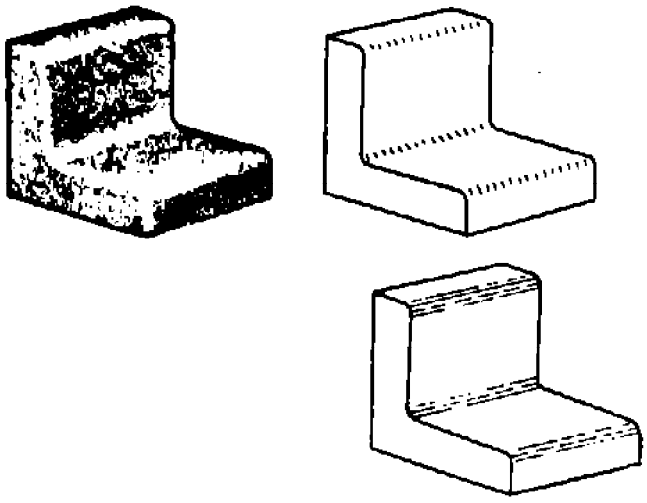


SECTIONAL VIEWS AND SECTION LINING
Fig. 55

20.7 Fillets and Rounds

Fillets and rounds usually show as highlights and for best results, they should be so treated. However, the practice of showing them by means of straight or curved lines is accepted as a satisfactory substitute. See Fig. 57.

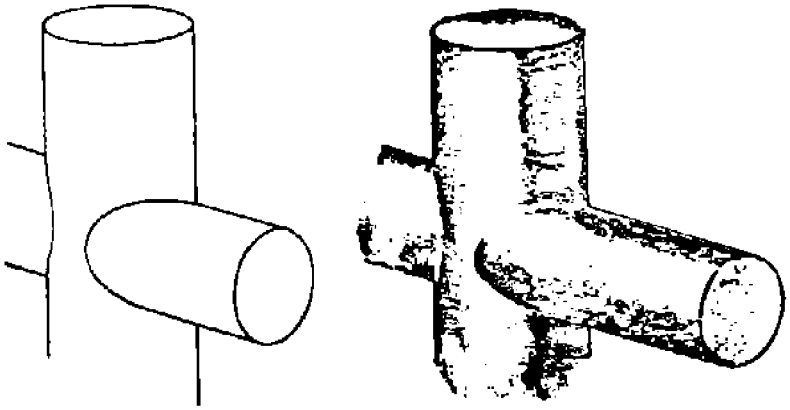
SECTION THROUGH ASSEMBLY
Fig. 56



FILLETS AND ROUNDS
Fig. 57

20.8 Intersections

All intersections should be constructed accurately and shown by line or by shading as indicated in Fig. 58.



INTERSECTIONS
Fig. 58

20.9 Thread Representation

Threads may be represented by a series of ellipses or circles uniformly spaced along the center line of the thread. A little shading will increase the effectiveness of the thread appearance. See Fig. 59. Threads should be evenly spaced, but it is not necessary to reproduce the actual pitch.

20.10 Dimensioning

Any pictorial can be dimensioned although the scaleability varies with the kind of projection used. The same rules of dimensioning used in conventional multiview drawings should be applied when possible.

20.10.1 Plane of dimension lines

Dimension line, extension lines and the line being dimensioned should lie in the same plane.

20.10.2 Foot and inch symbols

Rules for foot and inch symbols are the same as for conventional multiview drawings.

20.10.3 Unidirectional dimensioning

All lettering should be made with vertical letters and should read from the bottom of the sheet. See Fig. 60 (a).

20.10.3.1 Arrow heads

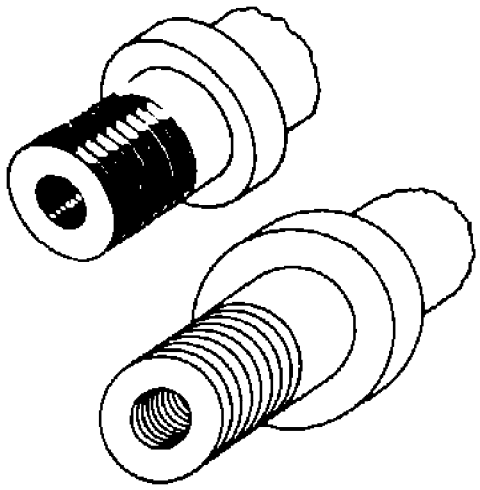
Arrow heads should be made as in conventional multiview drawings. See Fig. 60 (a).

20.10.3.2 Numerals

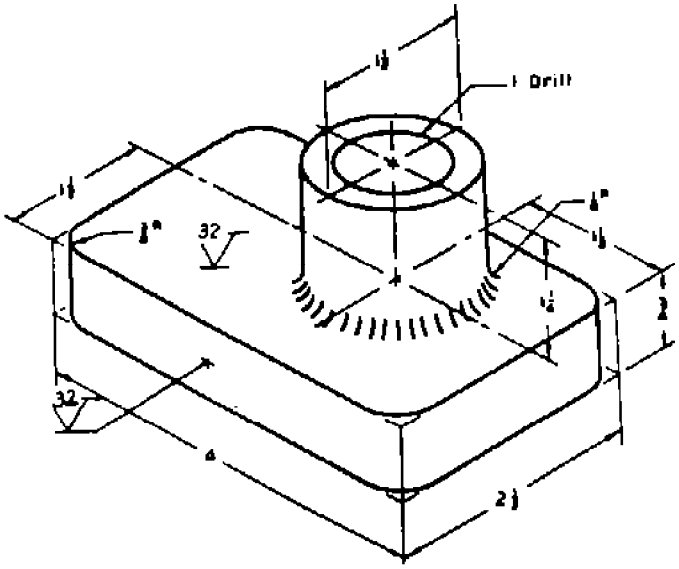
Dimension numerals should be made vertically, using the unidirectional system of dimensioning. See Fig. 60 (a).

20.10.3.3 Notes

Notes should be made so that they lie in or parallel to the picture plane, using vertical lettering on horizontal lines. They should be outside the view whenever possible. See Fig. 60 (a).



REPRESENTATION OF THREADS
Fig. 59



UNIDIRECTIONAL DIMENSIONING
Fig. 60 (a)

20.10.4 Pictorial plane dimensioning

All lettering should lie in one of the pictorial planes.

20.10.4.1 Arrow heads

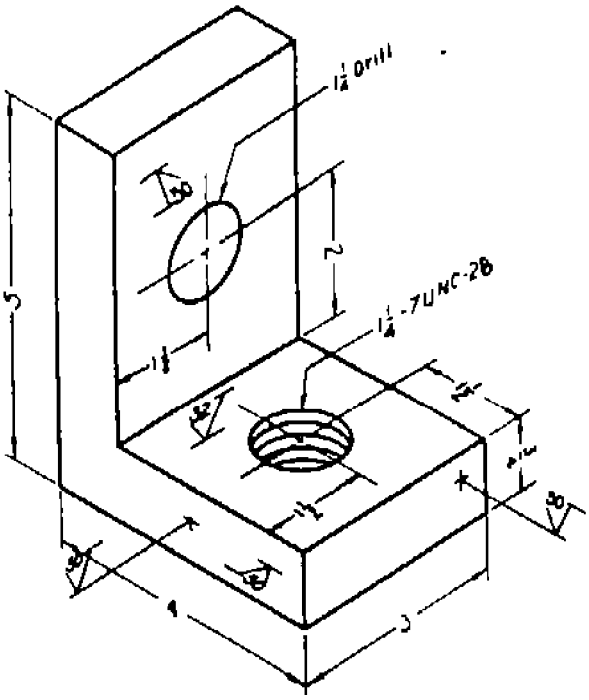
Arrow heads should be long and narrow and should lie in the plane of the dimension and extension lines. See Fig. 60 (b).

20.10.4.2 Numerals

Dimension numerals should lie in the plane of the dimension and extension lines and should read as shown in Fig. 60 (b).

20.10.4.3 Notes

Notes should lie on or parallel to one of the principal planes of the object, preferably one of the vertical faces and they should be outside the view whenever possible.



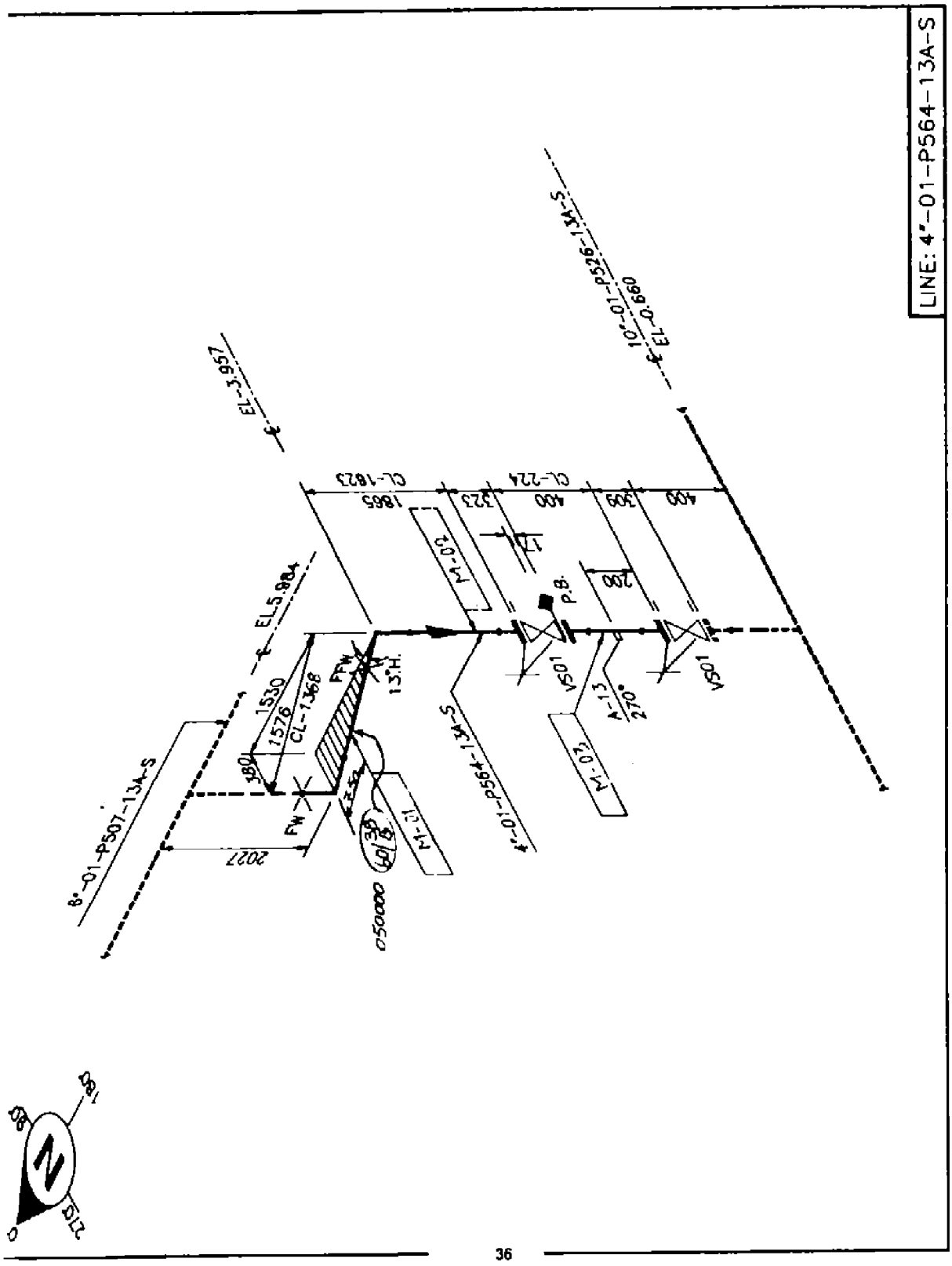
PICTORIAL PLANE DIMENSIONING
Fig. 60 (b)

APPENDICES

APPENDIX 1
MATERIAL TAKE OFF SHEET

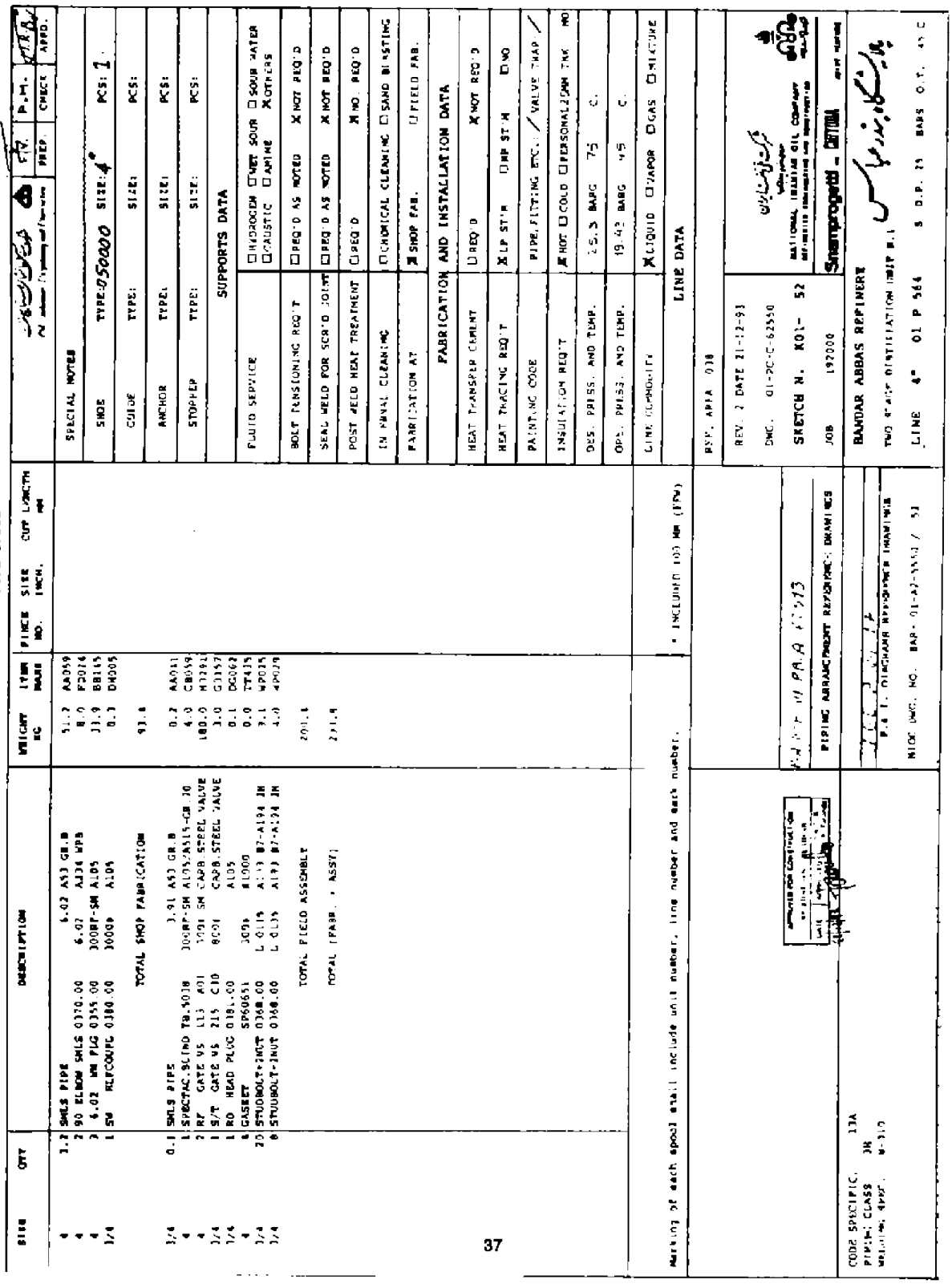
JOB TITLE		GACH SARAN P.U.3 EXP. FROM 72,000 M³/d TO 83,000 M³/d			
BUDGET No. 6-212		JOB No. 1709	J.A.F/A.F.E No.		
DRAWING No. F4A - 501616		PREPARED BY ARPI	PHR. No. 31-21-9560-02-01		
DATE 16 SEPT. 1974		CHECKED BY W.E.			
ITEM No.	M.E.S.C.	DESCRIPTION	UNIT	QTY.	MR ITEM No.
1	74-13-02-0721	2" Line Pipe Scrd. API- WT. 4.0	m.	2	50
2	74-13-23-1221	4" Line Pipe API- GR.B W.T. 5.9	m.	25	52
3	74-13-23-1701	6" Line Pipe API-GR"B" W.T.11.0	m.	52	54
4	74-13-23-1961	8" Line Pipe API-GR.B W.T. 7.1	m.	1	57
5	75-37-32-0261	6"Gate Valve Flgd.ASA. CL. 150	No.	1	58
6	76-05-39-1201	2" Elbow 45° L.R.B.W. W.T. 7.1	No.	2	61
7	76-30-38-2821	8" Elbow 45° L.R.B.W. W.T. 12.5	No.	4	62
8	76-30-71-3051	6" × 4" RED. ECC. W.T. 7.1 × 5.9	No.	1	63
9	76-30-84-2451	4" Tee Equal B.W.W.T. 5.9	No.	2	64
10	76-62-10-0761	6" Flange Blind RF. CL. 150	No.	1	66
11	76-62-10-0781	8" Flange Blind R.F.CL. 150	No.	1	67

APPENDIX 2
SPOOL DRAWING



36

APPENDIX 3
SUMMARY OF MATERIAL FOR PIPE SPOOLS



37

APPENDIX 4
TITLE BLOCK