Chapter 4

DRAWINGS AND SPECIFICATIONS

Engineering Practices

ENPRA101A

Topic 4-1

DRAWING INTERPRETATION

ENPRA101A – Engineering Practices

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INTRODUCTION

- An engineering drawing is a legal document because it communicates all the needed information about "what is wanted" to the people who will expend resources turning the idea into a reality’
- To eliminate ambiguous communication, engineering drawings are often made professionally and expected to follow certain national and international standards.
- In Australia the applicable standards are the AS 1100 series and the AS 1102 series.

AUSTRALIAN STANDARDS

- SAA/SNZ HB3:1996 - *Handbook - Electrical And Electronic Drawing Practice For Students*
- SAA/SNZ HB1:1994 – *Handbook - Technical Drawing For Students*
- AS 1100 series - *Technical drawing*
- AS 1101 series - *Graphic symbols for general engineering*
- AS/NZS 1102 series - *Graphical Symbols For Electrotechnology*
- AS/NZS 1103 series - *Preparation Of Documents Used In Electrotechnology*
- AS 3702 - *Item Designation In Electrotechnology*
- AS ISO 128 series - *Technical Drawings—General Principles Of Presentation*

EQUIPMENT AND MATERIALS

Drawing board and Tee square

Fig. PF-4-1-1 Drawing board and Tee square

EQUIPMENT AND MATERIALS

Set Squares 60/30, 45 and Adjustable Set Square

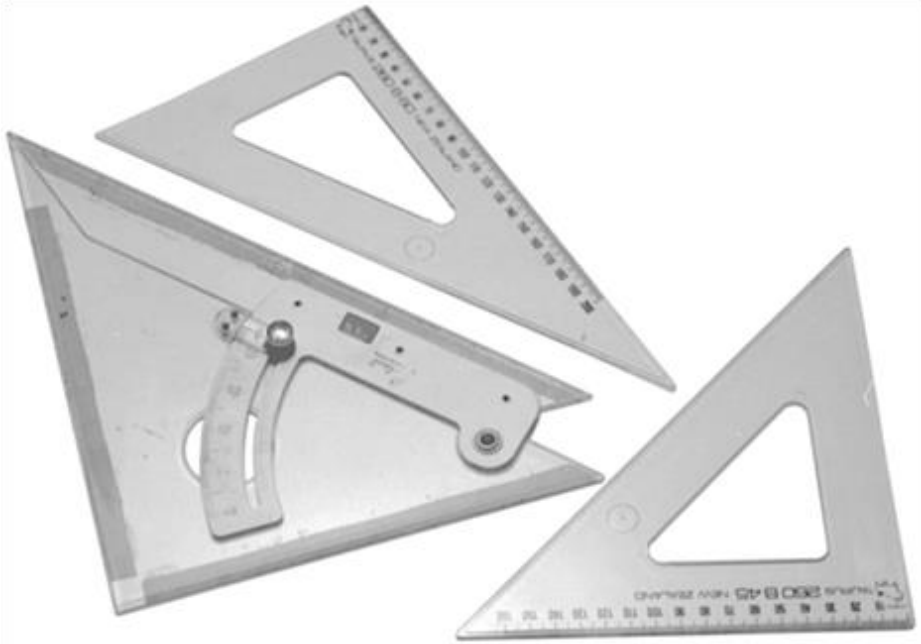


Fig PF-4-1-2 Set Squares and Adjustable Set Square

EQUIPMENT AND MATERIALS

Pencils

- Used mainly for marking off – for reproducible drawings ink is used. Pencils come in a range of hardness as shown below

Fig. PF-4-1-3 Pencil Hardness Scale

EQUIPMENT AND MATERIALS

Erasers

- Art gum type for removing marking off pencil lines and an ink eraser.

Erasing Shield

- Used to shield areas of the drawing that are not to be erased, the erasing shield is a piece of very thin shim stainless steel with different shape openings.

Fig PF-4-1-4 Erasing Shield

EQUIPMENT AND MATERIALS

Scale Rules

- Used to convert between scaled drawings and the actual dimensions. Typical scales available are 1:1, 1:5, 1:20, 1:50, 1:100, 1:200, and 1:500

Fig PF-4-1-5 Typical Scale Rule

EQUIPMENT AND MATERIALS

Bow Compass Drawing Set

- Used for drawing circles and arcs in both pencil and ink

Fig PF-4-1-6 Bow Compass Set

EQUIPMENT AND MATERIALS

Protractor

- Used to measure angles.

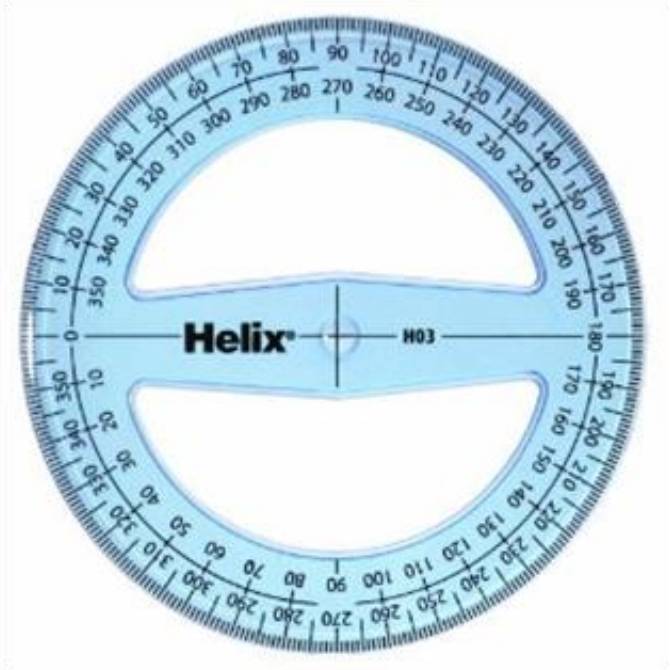


Fig PF-4-1-7 A 360° Protractor

EQUIPMENT AND MATERIALS

French curves and flexible curves

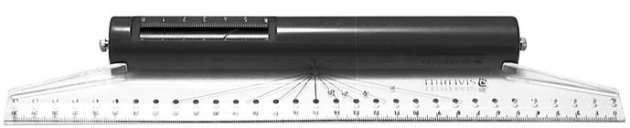
- Used to create a smooth flowing curves. The flexible curves are of flexible material, which may be bent to obtain the desired curve.

Fig PF-4-1-8 French Curve and Flexible Curve

EQUIPMENT AND MATERIALS

Parallel rules

- Used for drawing parallel lines if no tee square of drafting machine available.



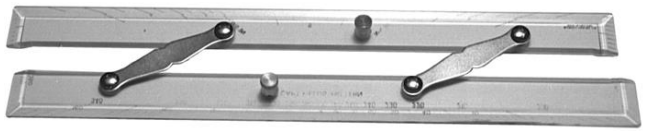


Fig PF-4-1-9 Parallel Rules

EQUIPMENT AND MATERIALS

Ink pens and pen sets

- Used for drawing different thickness lines. The most commonly used pens and line thicknesses are 0.25, 0.35, 0.5 and 0.7.

Fig PF-4-1-10 Ink Pens in Various Line Thicknesses Thi360° Protractor

EQUIPMENT AND MATERIALS

Drawing paper

- Tracing paper was and is still used for ink drawings where a chemical process is used for reproduction.
- More likely drawings are done on a CADD system and printed using a plotter or printer where ‘normal’ type paper can be used.

EQUIPMENT AND MATERIALS

Drawing paper (Cont'd)

- Engineering drawings are done on standard metric size sheets that correspond to international paper sizes, known as the A series.
  - A4 = 210mm X 297mm
  - A3 = 297mm X 420mm
  - A2 = 420mm X 594mm
  - A1 = 594mm X 841mm
  - A0 = 841mm X 1189mm

DETAIL AND ASSEMBLY DRAWINGS

Some of the different types of drawings used in engineering drawing are:

- **Mechanical Drawings** which include:
  - Detail drawings
  - Assembly drawings
  - Sub-assembly drawings
  - Exploded views
  - Pictorial views

DETAIL AND ASSEMBLY DRAWINGS

different types of drawings (Cont'd):

- **Electrical Drawings** which include:
  - Component details
  - Block diagrams
  - Circuit diagrams
  - Wiring diagrams

ASSEMBLY DRAWINGS

- An assembly drawing (see **Fig. PF-4-1-11**) shows how a collection of parts, standard components and sub-assemblies fit together into a finished product.
- Every set of working drawings should include at least one assembly drawing.
- Assembly drawings should include reference letters and numbers representing the different parts. These part numbers are usually enclosed by circles with a leader pointing to the piece.

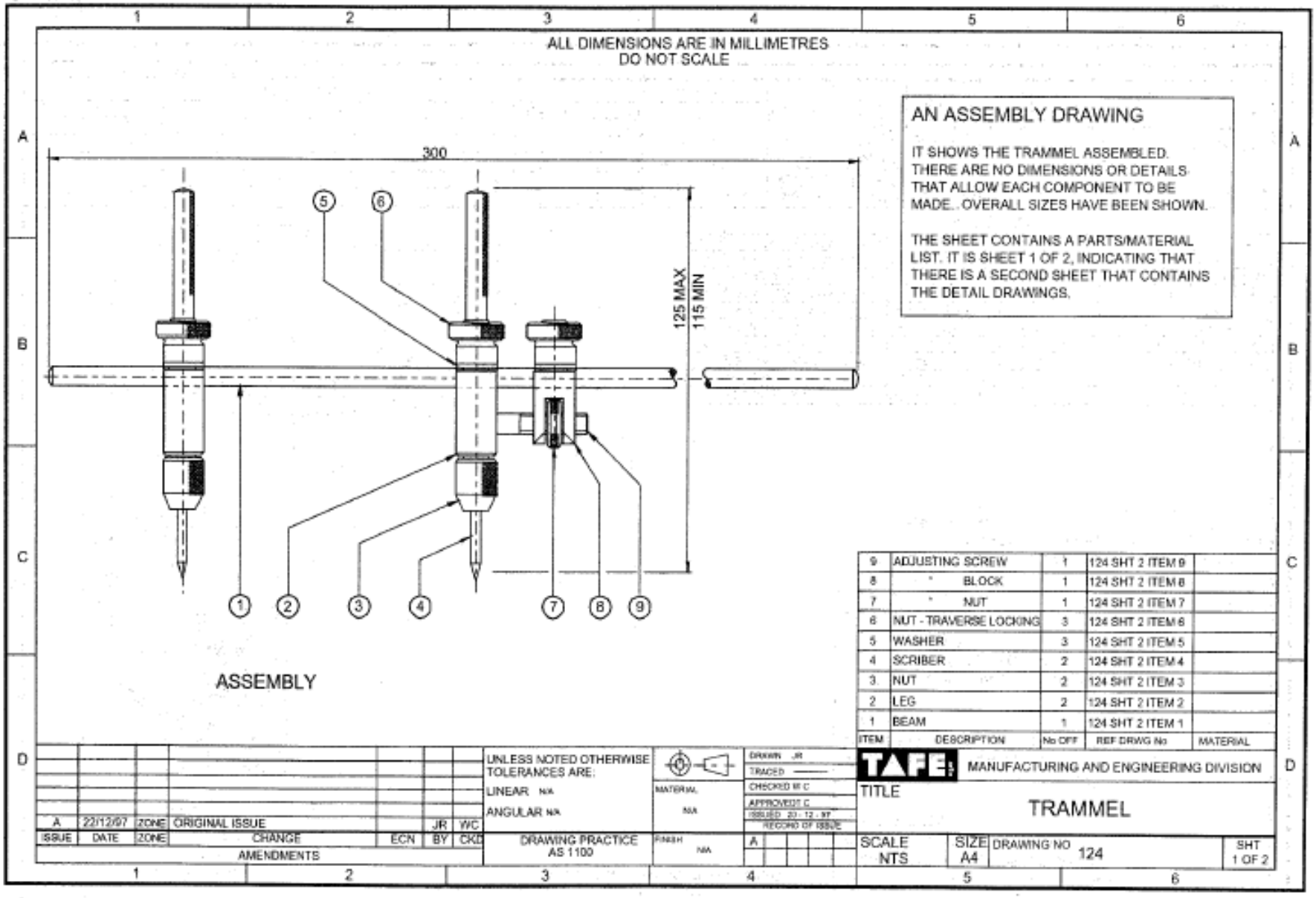


Fig. PF-4-1-11 Example of an Assembly Drawing

DETAIL DRAWINGS

- A detail drawing (See **Fig. PF-4-1-12**)is a drawing of a part or component which provides all the information needed to fabricate the part.
- This includes the part's shape, dimensions, material, and any special requirements, e.g.. surface finish or heat treatment.
- Normally three orthographic views (front, top, and right side) should be shown.
- Orthographic views should be shown in third angle projection.

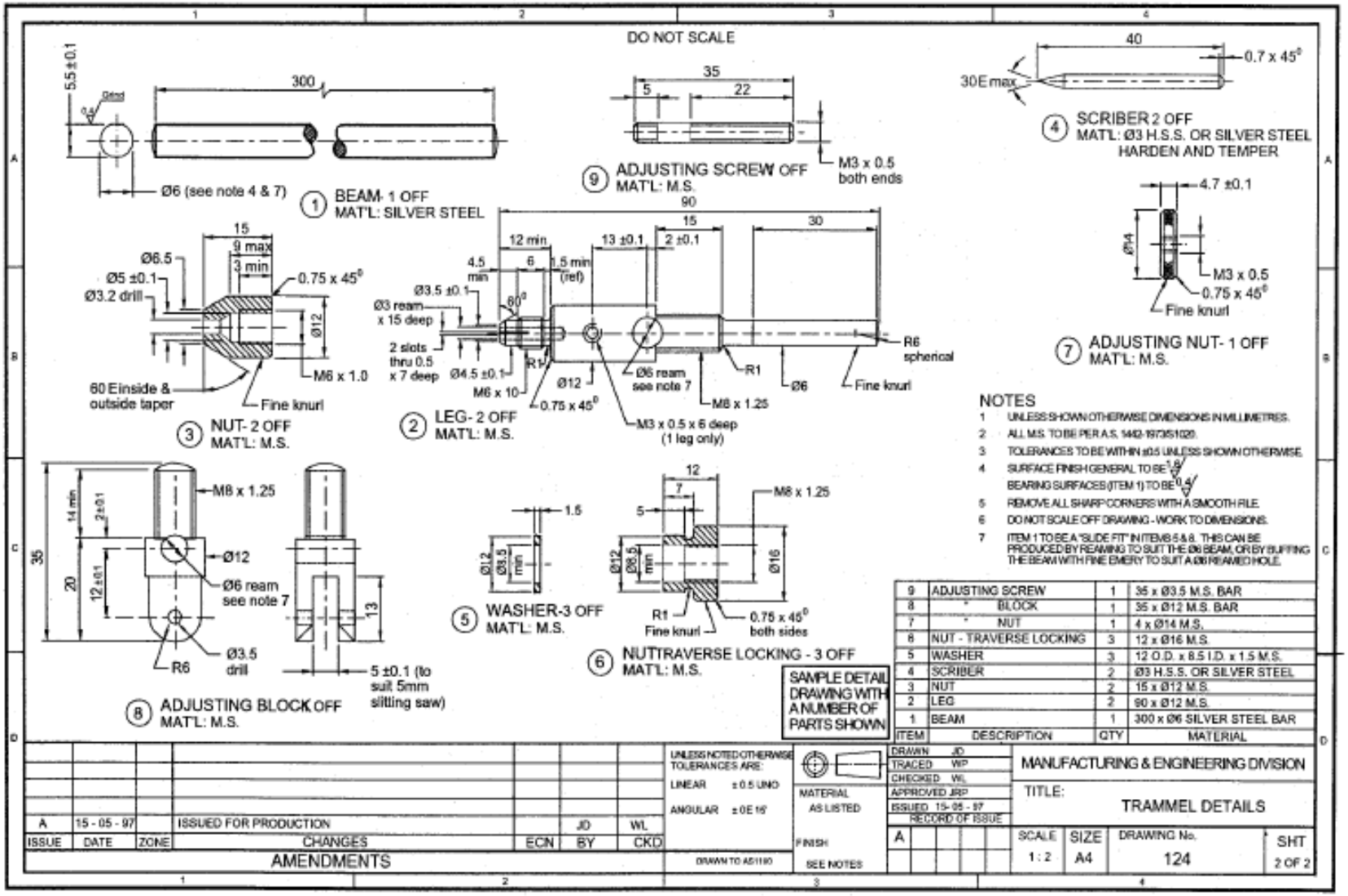


Fig. PF-4-1-12 Example of a Detail Drawing (Details of parts required for assembly of Fig. PF-4-1-11)

DRAWING SHEET LAYOUT

- Every drawing should have:
  - title block (which will contain Drawing title, Drawing number, Drafter/Checker/Approver, Drawing sheet size, Scale (See Fig **PF-4-1-14**)
  - parts list
  - revision list.
- Most drawings also have:
  - a grid reference system to aid in locating a particular item
  - Projection method (usually in the form of a symbol) – see **Figs. PF-4-1-13(a) and PF-4-1-13(b)**

DRAWING SHEET LAYOUT

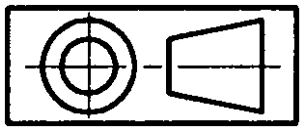


Fig. PF-4-1-13(a)
Third angle projection

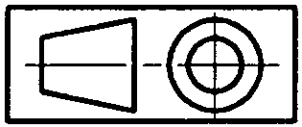


Fig. PF-4-1-13(b)
First angle projection

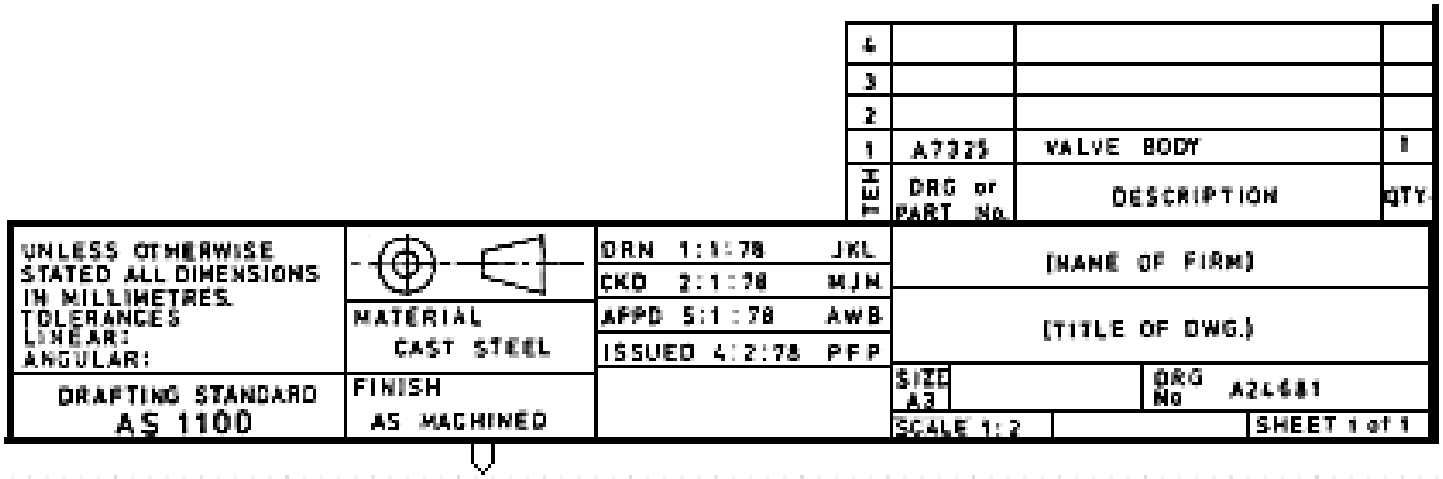


Fig. PF-4-1-14 – Typical title block

DRAWING SHEET LAYOUT

Line Types

- Different line thicknesses and types are used for different roles on drawings (see table PT-4-1-1)

Dimensioning of drawings

- The dimensions shown on a drawing are those needed to produce the object.
- Dimensions must be placed on the drawing in accordance with the current drawing standards.
-

Type of line and weight	*Type designation and example*	*Application*	*Approximate thickness on A3 size sheet in mm*
Continuous - thick	A ———	Visible outlines Border lines	0.7
Continuous - thin	B ———	Dimension lines Projection lines Leaders lines Fold lines Short centre lines Hatching	0.35
Continuous – thin freehand or rules with zig-zag	C ~~~	Break lines	0.35
Dashed - medium	D – – – –	Hidden outlines	0.5
Chain - thin	E —·—·—	Centre lines Pitch lines Alternative position of moving parts	0.35
Chain – thick at ends and at change of direction, otherwise thin	F —·—	Indication of section planes	0.35

Table PT-4-1-1 – Line Types and Applications

DRAWING SHEET LAYOUT

Symbols

- Symbols permit consistency in the way dimensions and tolerances are specified, and each symbol has a clearly defined meaning. See **Tables PT-4-1-2** and **PT-4-1-3**

Scaling

- It is not possible to fit some items on to a drawing sheet in their original size therefore scaling is necessary . **Table PT-4-1-4** shows recommended scales.

Symbol	*Description*	*Example*
Ø	To indicate a diameter	Ø50
R	To indicate radius	R30
□	To indicate a square section	□ 75
→	To indicate a taper and its direction	→ 3:100
◺	To indicate a slope and its direction	1:10
( )	To indicate a reference dimension	
———	To indicate a dimension not to scale	

Table PT-4-1-2 – Dimensioning Symbols

℄	Indicates the centre-line of a part, feature, or group of features. It shall be located to or on the centre-line
SØ	Indicates the diameter of spherical surface, it shall be placed in front of the dimension
SR	Indicates the radius of spherical surface, it shall be placed in front of the dimension
	Indicates a countersink, it shall be placed in front of the dimension
	Indicates counterbore or spotface, must be placed in front of the dimension
	Indicates depth of the feature, this must be situated in front of the dimension
	Indicates that the dimension refers to an arc length, this must be placed above the dimension

Table PT-4-1-3 – More Dimensioning Symbols

Enlargement	*Full size*	*Reduction*		
10:1	1:1	1:2	1:5	1:10
5:1		1:20	1:50	1:100
2:1		1:200	1:500	1:1000
		1:2000	1:5000	1:10 000

Table PT-4-1-4– Recommended Scales – AS1100

DRAWING SHEET LAYOUT

Fabrication Symbols

- Fabrication symbols convey requirements for surface finish (**Fig. PF-4-1-15**) and type of weld (**Fig. PF-4-1-16**)

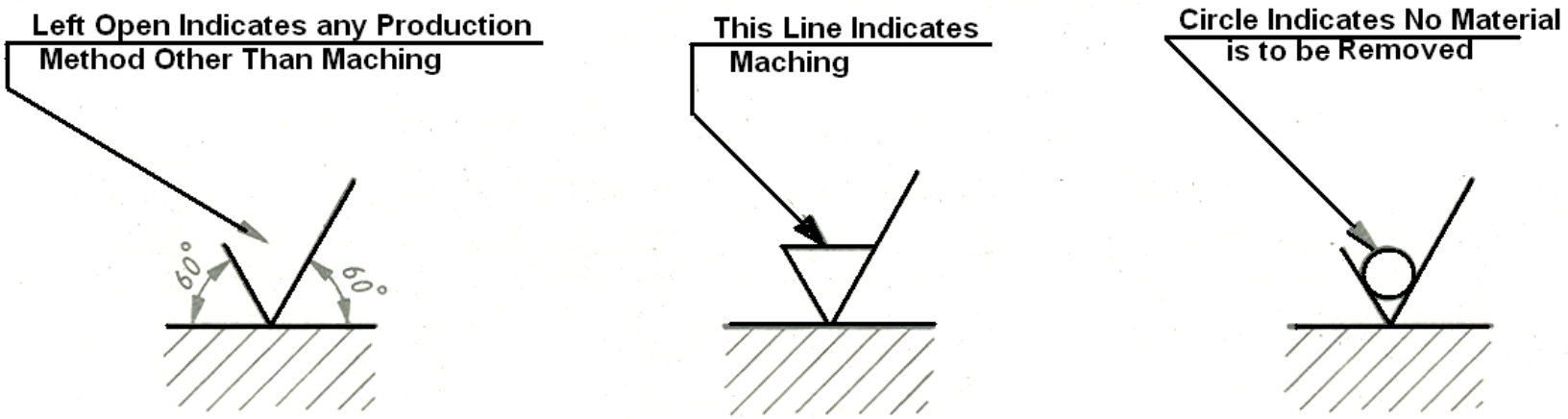
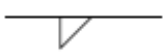
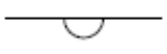
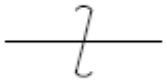
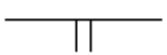
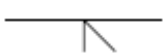
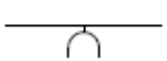
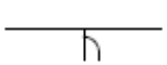
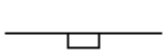
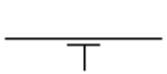
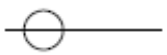
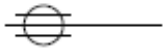
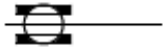
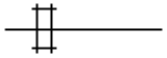
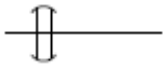


Fig. PF-4-1-15 – Symbols used to Indicate Surface Texture

BASIC GAS AND ARC WELDING SYMBOLS	
	FILLET
	BEAD
	GENERAL BUTT
	SQUARE BUTT
	SINGLE BEVEL BUTT
	SINGLE VEE BUTT
	SINGLE 'U' BUTT
	SINGLE 'J' BUTT
	PLUG OR SLOT
	STUD
	SURFACING

REISITANCE WELDING SYMBOLS	
	SPOT
	SEAM
	MASH SEAM
	STICH
	MASH STICH
	PROJECTION
	FLASH BUTT
	RESISTANCE BUTT

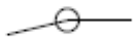
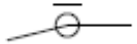
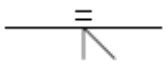
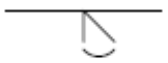
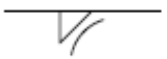
SUPPLEMENTARY WELDING SYMBOLS	
	WELD ALL ROUND
	FLUSH CONTOUR
	WELD ON SITE
	BACKING STRIP OR BAR
	FLUSH SURFACE FINISH
	CONVEX SURFACE FINISH
	CONCAVE SURFACE FINISH
	BACKING WELD RUN
 TYP	TAIL, FOR NOTES

Fig. PF-4-1-16 – Welding Symbols

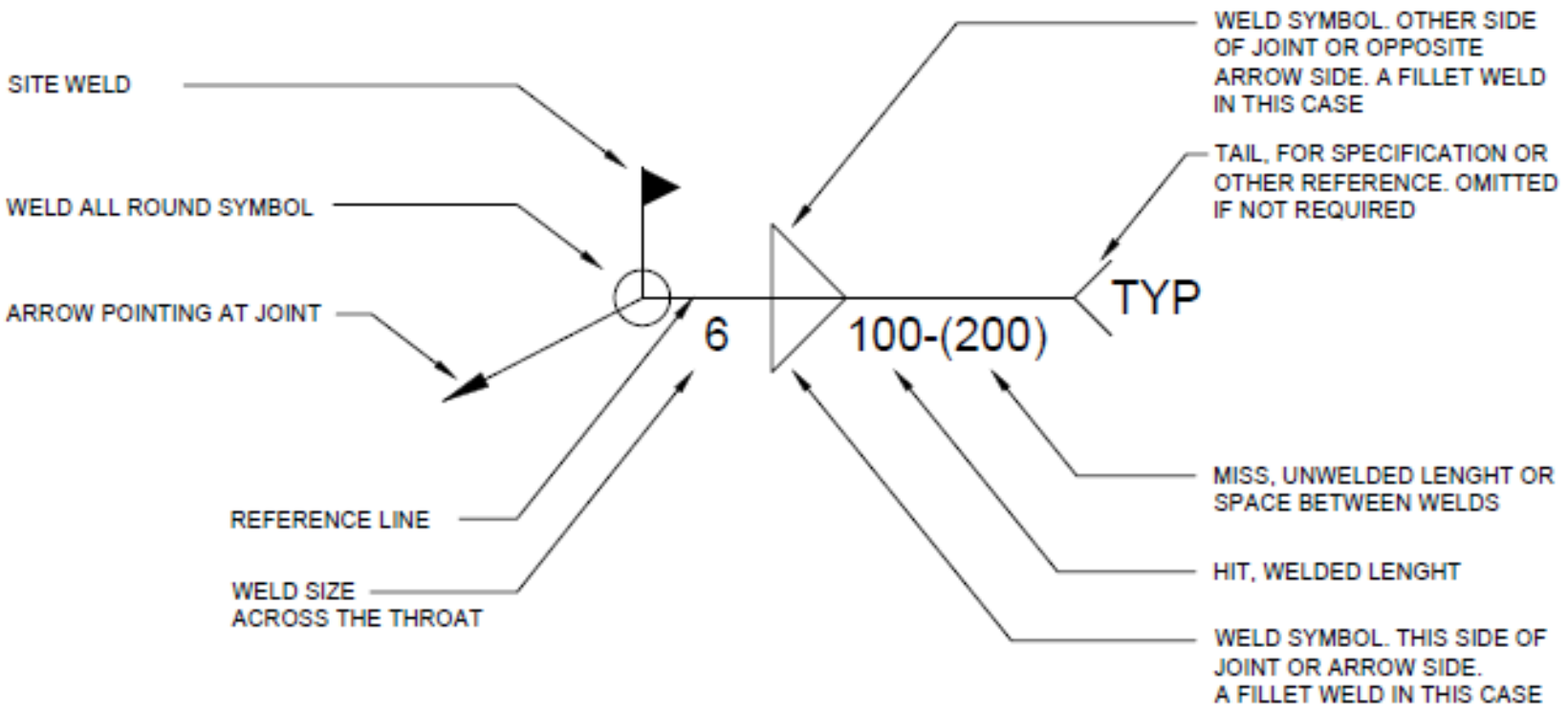


Fig. PF-4-1-17 – Interpretation of Welding Symbols

DRAWING SHEET LAYOUT

Representing screw threads

- Screw threads are shown simply by parallel lines representing the minor and major diameters as shown below in Table **PT-4-1-5**

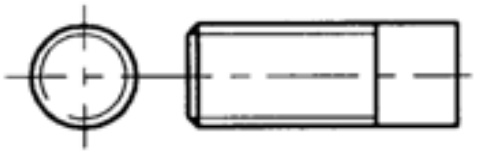
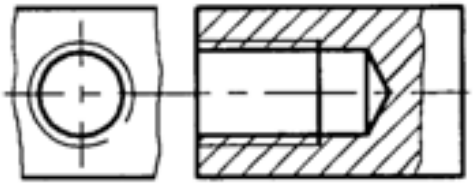
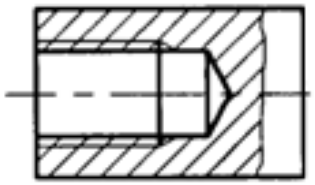
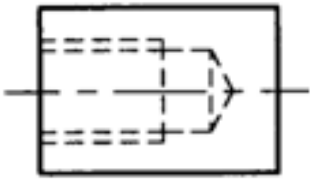
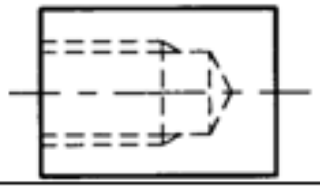
Description	Conventional representation
External V-form thread	
External V-form thread Showing thread run-out	
Internal V-form thread	
Internal V-form thread Showing thread run-out	
Internal V-form thread (hidden)	
Internal V-form thread (hidden) Showing thread run-out	

Table PT-4-1-5 – Representation of Screw Threads

PROJECTION METHODS OF DRAWING

- An engineering drawing must ideally show the true shape of an object as well as all necessary sizes to allow it to be made and interpreted correctly.
- A pictorial drawing (axonometric, oblique or perspective) may give an instant impression of an object and its use, but be ineffective in showing correct proportions and dimensions as an orthogonal drawing would.

PROJECTION METHODS OF DRAWING

Orthogonal Projection

- In Australia 3rd angle projection is the preferred method for orthographic projection drawing as recommended by the AS 1100 Part 101.
- An orthogonal drawing is a two-dimensional drawing system where three dimensional objects are drawn in separate but aligned two-dimensional views:
  - a top or plan view,
  - front view and
  - side or end view/s

PROJECTION METHODS OF DRAWING

Orthogonal Projection (Cont'd)

- An example showing an isometric view of a simple bracket is shown in **Fig. PF-4-1-18(a)**, the corresponding orthographic views are shown in **Fig. PF-4-1-18(b)**

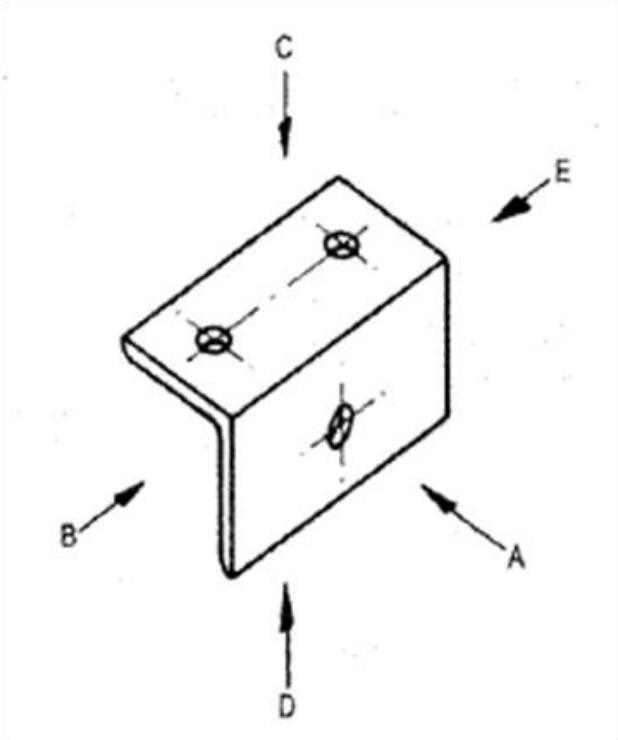


Fig PF-4-1-18(a) – Isometric View

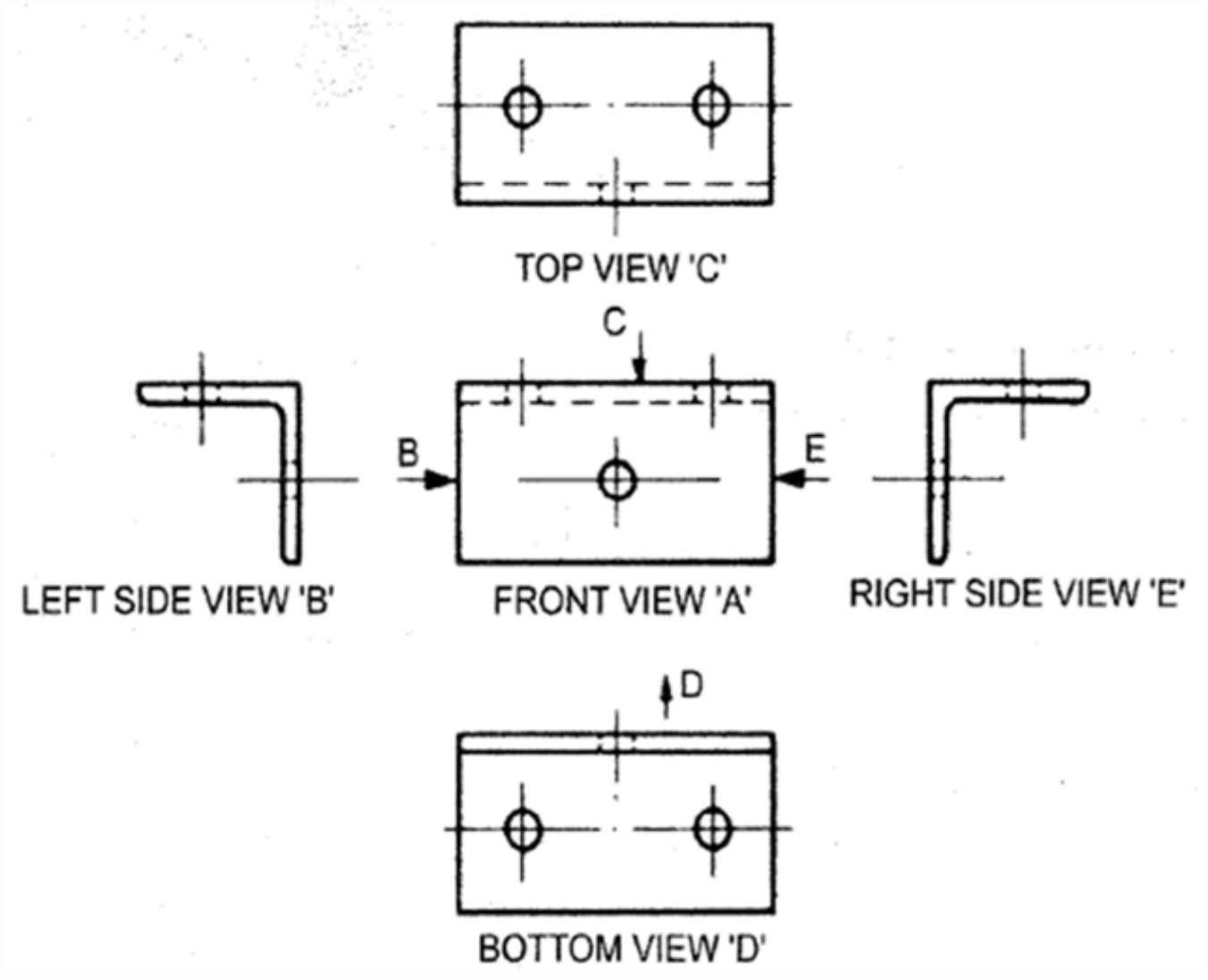


Fig PF-4-1-18(b) – Orthographic Views

PICTORIAL REPRESENTATION OF OBJECTS

- There are two basic ways of representing a three-dimensional object in pictorial form:
  - Isometric, or
  - Oblique, which is further divided into
    - Cavalier or
    - Cabinet

PICTORIAL REPRESENTATION OF OBJECTS

- **Isometric drawings** show three sides of an object, all in dimensional proportion, but none are shown as a true shape with 90° degree corners. All the vertical lines are drawn vertically but all horizontal lines are drawn at 30 degrees to the base line, see **Fig. PF-4-1-19** for example.

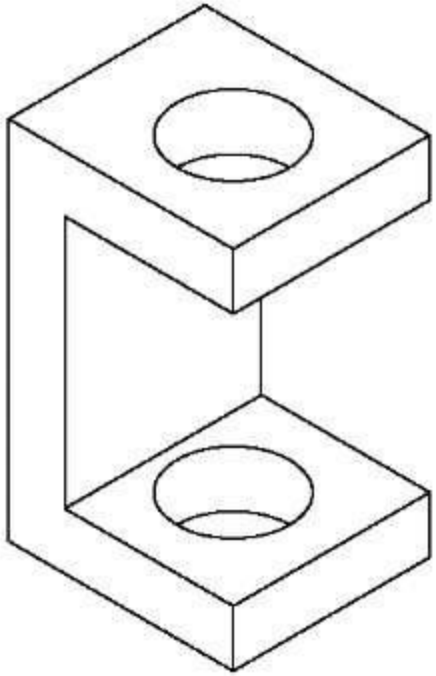


Fig PF-4-1-19 – Isometric View

PICTORIAL REPRESENTATION OF OBJECTS

Oblique Drawings

- The object is drawn as viewed from one of its orthographic faces.
- The front face of an oblique drawing is parallel to the front plane of projection, i.e. the front face is drawn to exact size and shape.
- The other two surfaces are projected from this front face at any convenient angle (usually 30° or 45°) and in any direction.

PICTORIAL REPRESENTATION OF OBJECTS

Oblique Drawings (Cont'd)

- There are two types of oblique drawings, cavalier and cabinet (see **Fig PF-4-1-20**).
- In **cavalier** drawings the lengths of the receding lines are drawn to full scale
- To reduce the amount of visual distortion, long receding lines are sometimes reduced by one-half, but dimensioned true size. When this is done, the drawing is known as an **oblique** drawing.

PICTORIAL REPRESENTATION OF OBJECTS

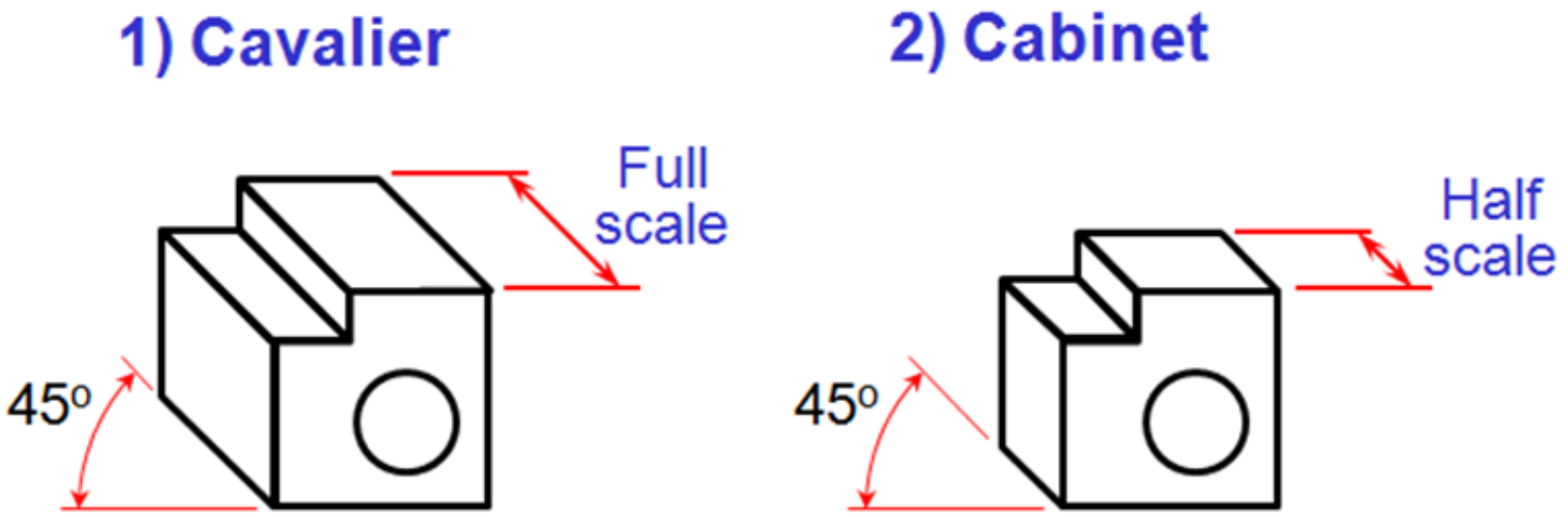


Fig PF-4-1-20 – Oblique Drawings

PICTORIAL REPRESENTATION OF OBJECTS

Perspective

- Used to show objects and buildings as they appear to the eye on completion. **Fig PF-4-1-21** is a single point perspective. The lines of projection from the front eventually meet at one point.

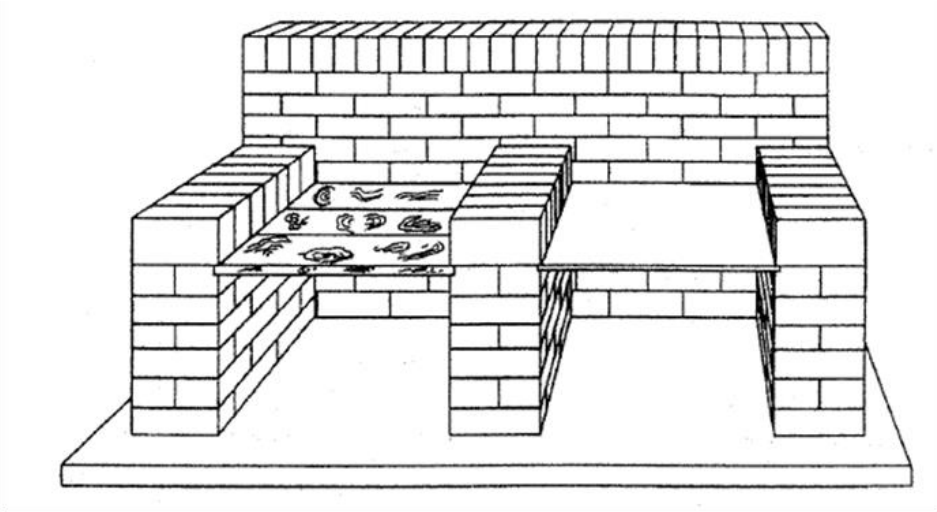


Fig PF-4-1-21 – Perspective Drawing

PICTORIAL REPRESENTATION OF OBJECTS

Exploded View

- This method is particularly good for showing those, who have little or no experience with reading diagrams, the assembly or disassembly of a mechanical component.

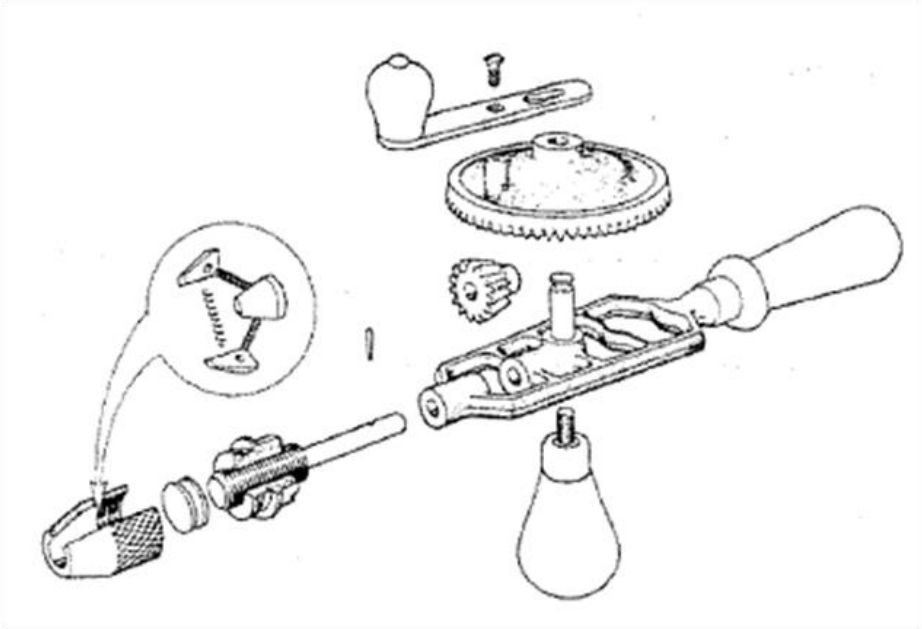


Fig PF 4-1-22 – Exploded View

SECTIONING AND HATCHING

- Sectioning is used to expose details of an object that cannot be adequately defined by external views.
- The object is cut by a surface (cutting plane), and the part of the object in front of the surface is removed to expose details of the cut object.
- Any area of the object that has been cut is indicated by hatching (**Fig. PF-4-1-23**).
- The position of the cutting plane is indicated on the drawing and the sectioned view is usually labelled to indicate which section plane is applicable.

SECTIONING AND HATCHING

- Hatching usually consists of a series of equally spaced thin parallel lines, drawn at about 45° to the edge of the drawing sheet.

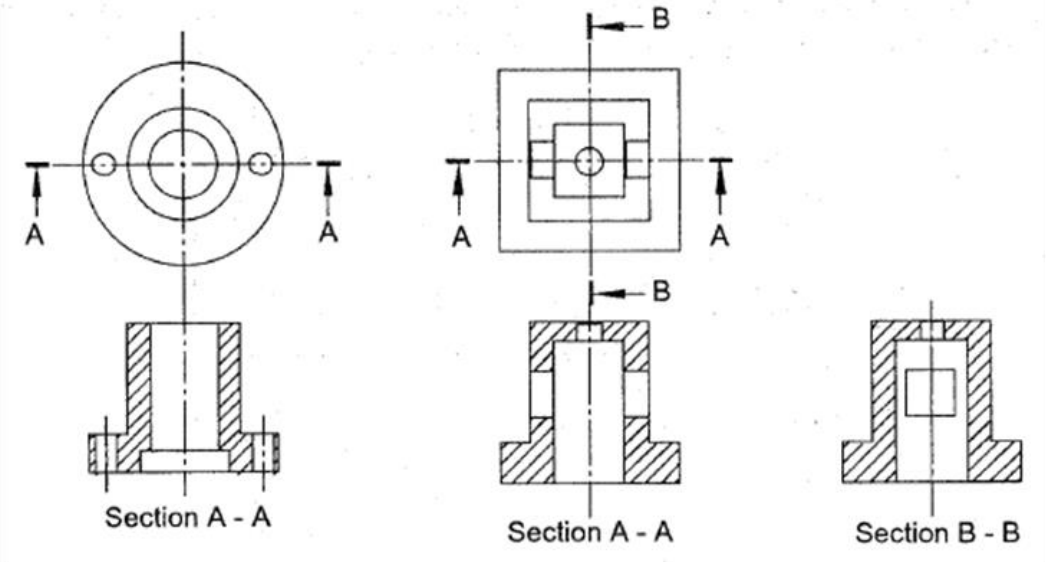


Fig PF-4-1-23
Sectional Views

ARCHITECTURAL DRAWINGS

- Architectural drawings are diagrams depicting various features related to the construction of buildings.
- The following types of drawing are grouped under 'Architectural' drawings:
  - **Floor plans** showing the layout of various rooms within a building. Floor plans are also used to show the location of various building service items such as lighting points, power outlets, switchboards, smoke detectors, plumbing outlets, etc. (See **Fig PF-4-1-24**)

ARCHITECTURAL DRAWINGS

- **Constructional drawings**, which show details of how the building is erected
- **Site plans** showing where the building is located on the block of land and the location of electrical mains, water, gas and other services (See **Fig PF-4-1-25**).

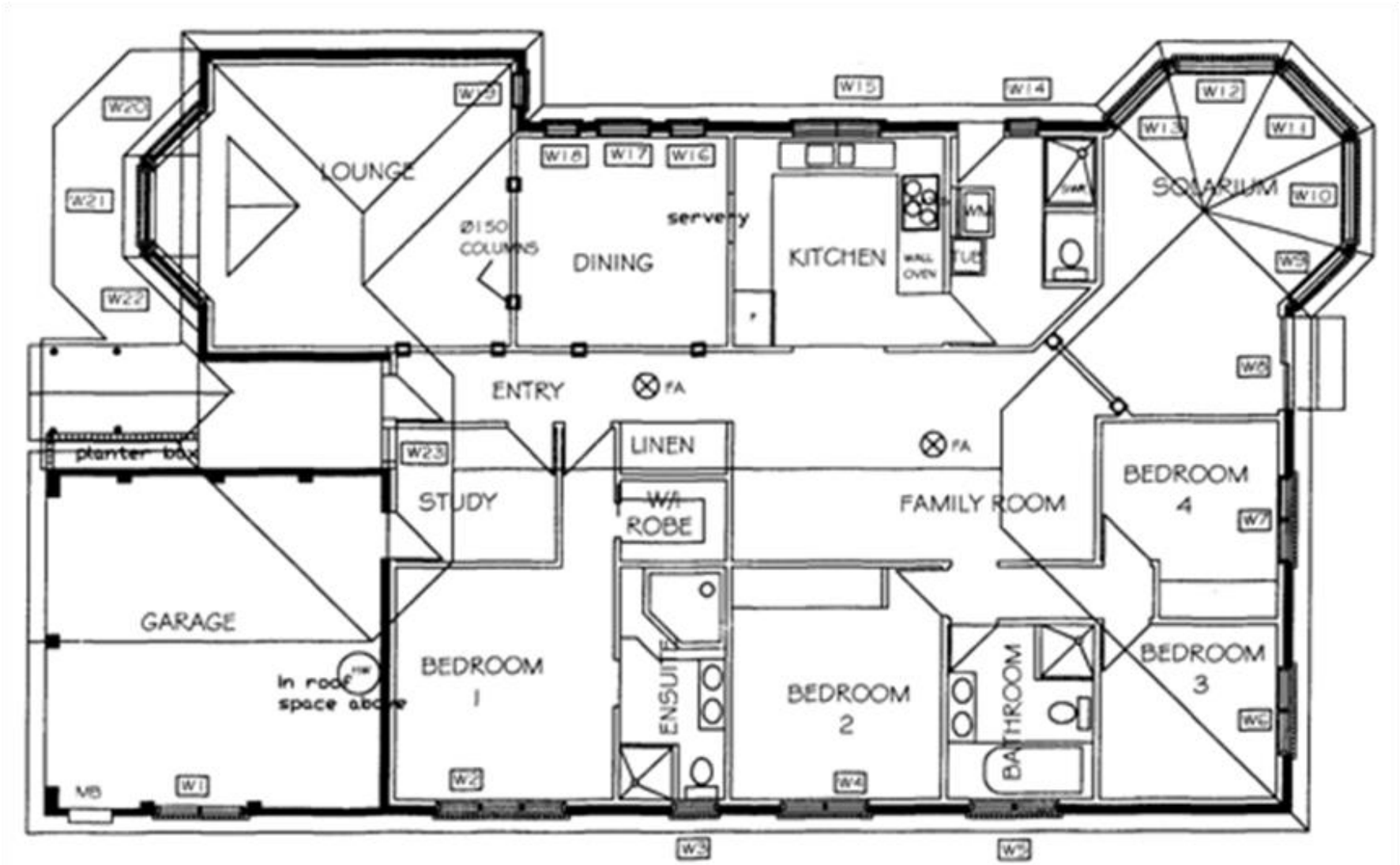


Fig PF-4-1-24 – Floor Plan

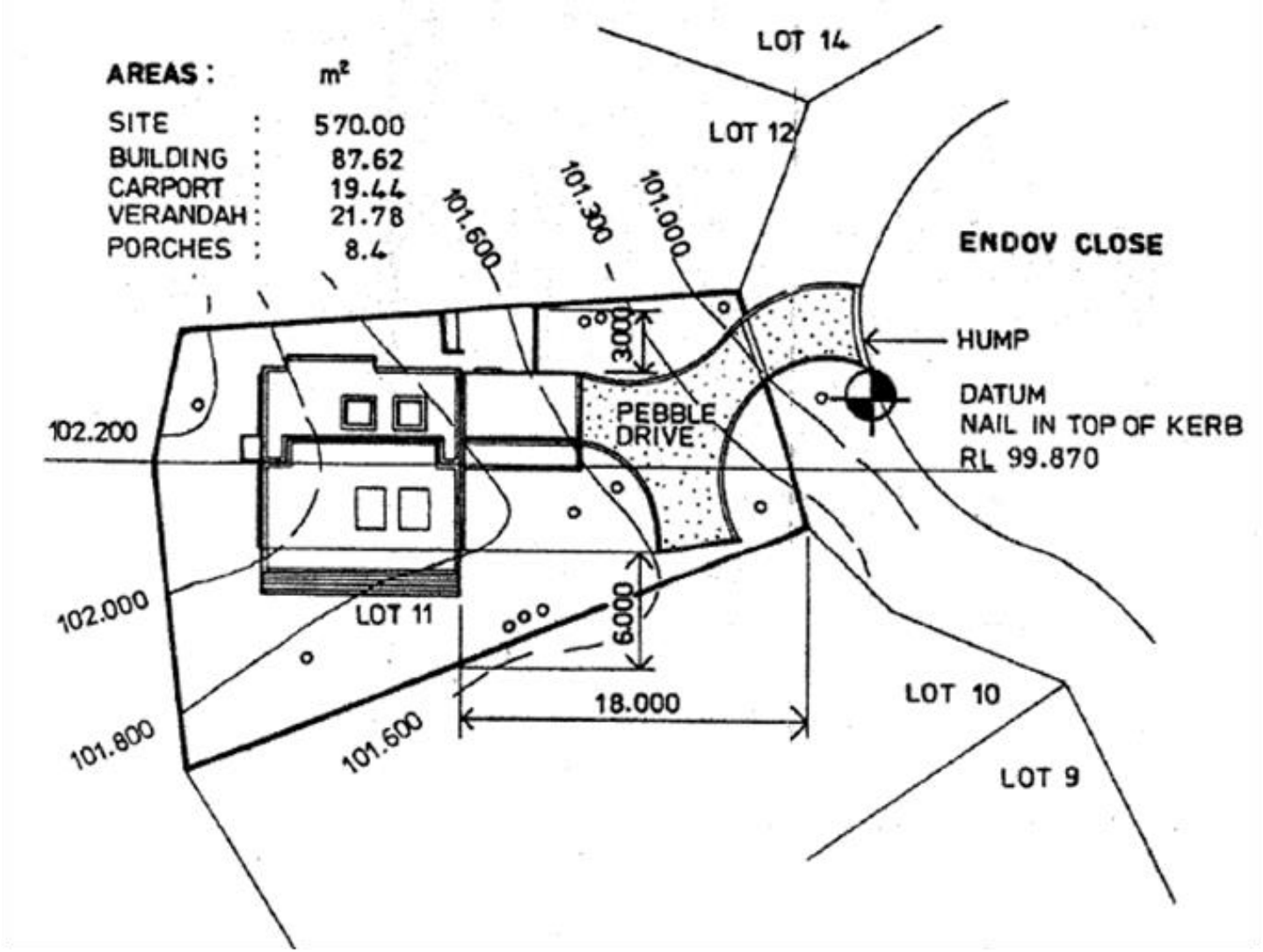


Fig F 4-1-25 – Example of a Site Plan

ELECTRICAL ARCHITECTURAL SYMBOLS

- The location of all electrical appliances and accessories is shown by the use of symbols on the floor plan.
- The symbols used are as specified in *AS 1102:111*
- Fig. **PF-4-1-26** read in conjunction with table **PT-4-1-6** shows a selection of frequently used symbols

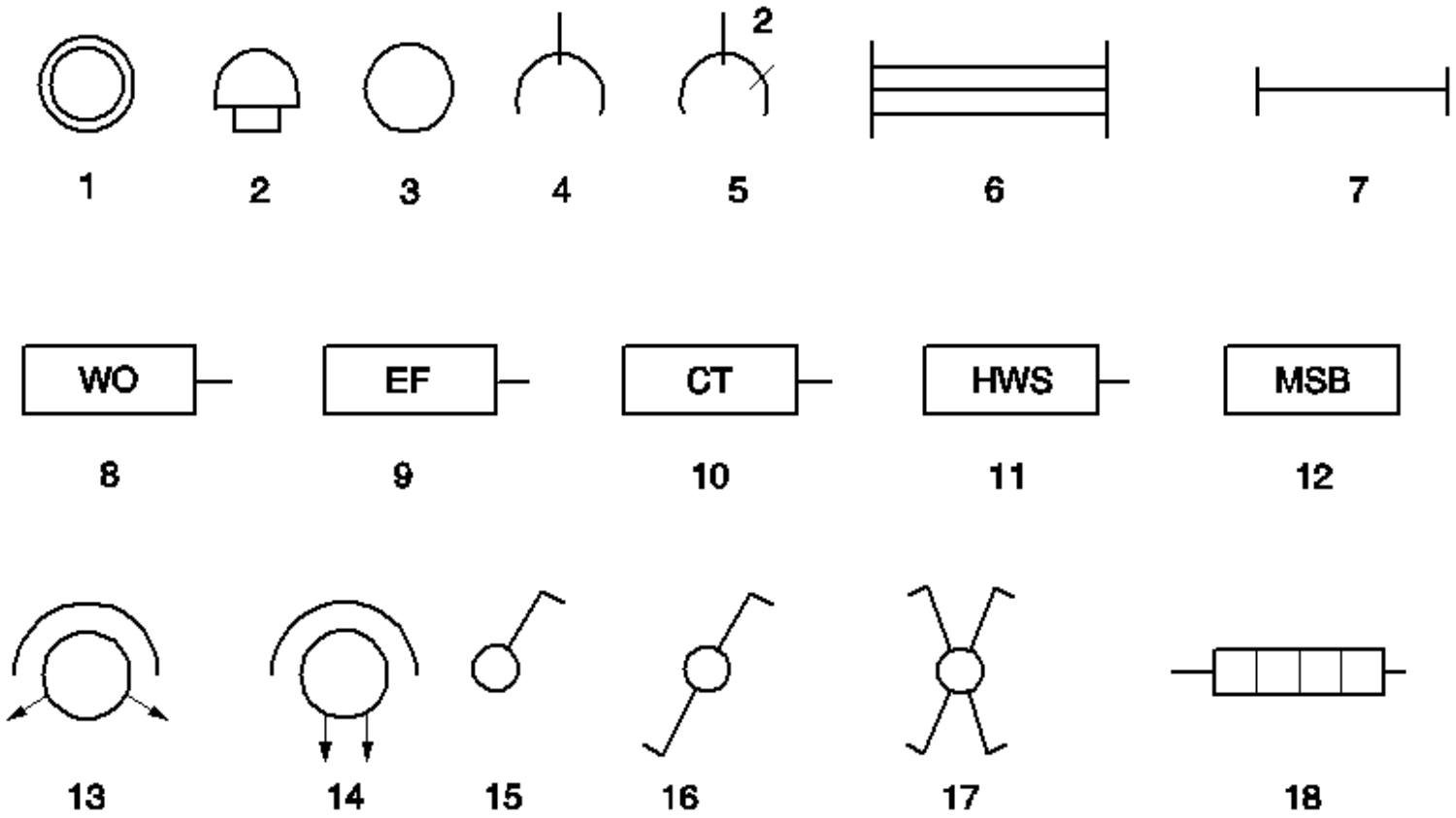


Fig. PF-4-1-26– Electrical architectural symbols

ELECTRICAL ARCHITECTURAL SYMBOLS

1	bell push	7	single fluorescent	13	flood lamp
2	bell	8	wall oven	14	spot lamp
3	lamp	9	exhaust fan	15	single-way switch
4	single GPO	10	cook top	16	two-way switch
5	double GPO	11	hot water system	17	intermediate switch
6	twin fluorescent	12	main switchboard	18	heater

Table PT-4-1-6– Electrical Architectural Symbols Key to **Fig. PF-4-1-26**

ELECTRICAL ARCHITECTURAL SYMBOLS

Summary

- Access to architectural drawings is essential for all stakeholders in both the planning and construction phases of a project
- Engineers planning and scheduling services must consult architectural drawings in order to:
  - plan the layout of equipment e.g. lighting and power, electrical reticulation, plumbing services, air conditioning ducting, fire services etc.

ELECTRICAL ARCHITECTURAL SYMBOLS

Summary (Cont'd)

- Co-ordinate the different trades for example if the floors are poured concrete then the electricians need to install their conduits before the concrete is poured.
- Be able to order the correct type of equipment, cables and fittings to suit the structure

ELECTRICAL DRAWINGS

- The different types of diagram used in the electrical/electronic industry, include:
  - block diagrams
  - circuit diagrams
  - wiring diagrams
  - architectural diagrams
  - single line diagrams.

BLOCK DIAGRAMS

- The block diagram is a concept diagram to aid in the understanding how a circuit or system operates. It does not provide detailed information of the components in the block. See Example below.

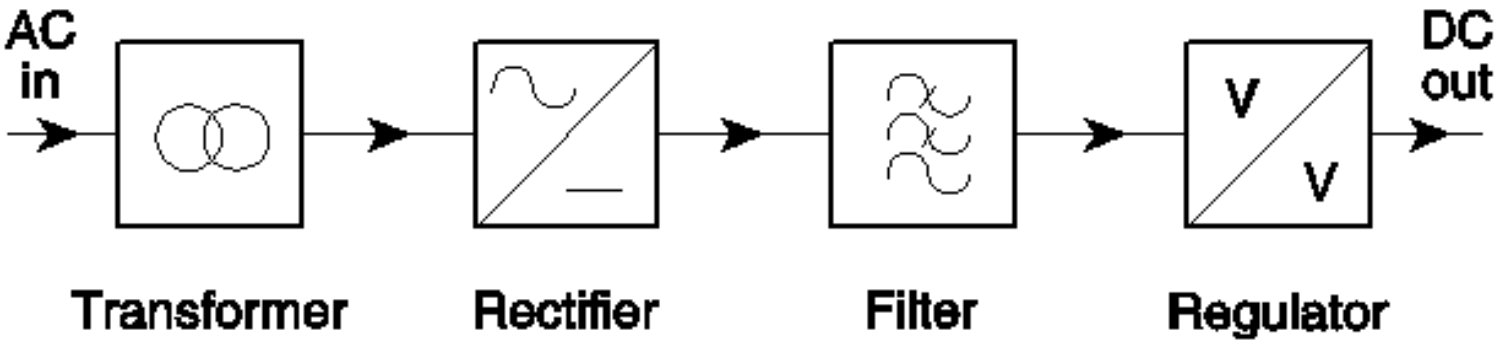


Fig. PF-4-1-27– Block Diagram Example - regulated power supply

CIRCUIT DIAGRAMS

- The circuit diagram gives more detail on the complete operation of a circuit or part of a circuit.
- Circuit diagrams are also referred to as *schematic diagrams*.
- All circuit diagrams contain symbols, which represent components or items of equipment. These symbols are interconnected by lines representing conductors.
- An example is shown in the circuit of Fig. **PF-4-1-28**.

CIRCUIT DIAGRAMS

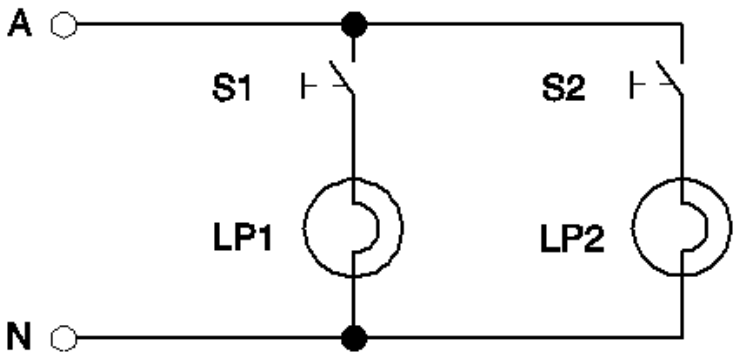


Fig. PF-4-1-28– Circuit Diagram Basic Lighting Circuit

- Symbols marked S1 and S2 are manually operated switches, LP1 and LP2 are incandescent lamps. The letter ‘A’ indicates the active conductor and the letter ‘N’ the neutral conductor. The solid dot (●) indicates a junction or join between conductors.

CIRCUIT DIAGRAM DRAWING CONVENTIONS

- Circuit diagrams are drawn with:
  - power flow left to right and operating sequence top to bottom (**Fig. PF-4-1-29**) OR
  - power flow top to bottom and operating sequence left to right (**Fig. PF-4-1-30**)
- Circuit diagrams are usually drawn in a detached representation for ease of understanding. That is, component parts of an item may be drawn remotely from one another.

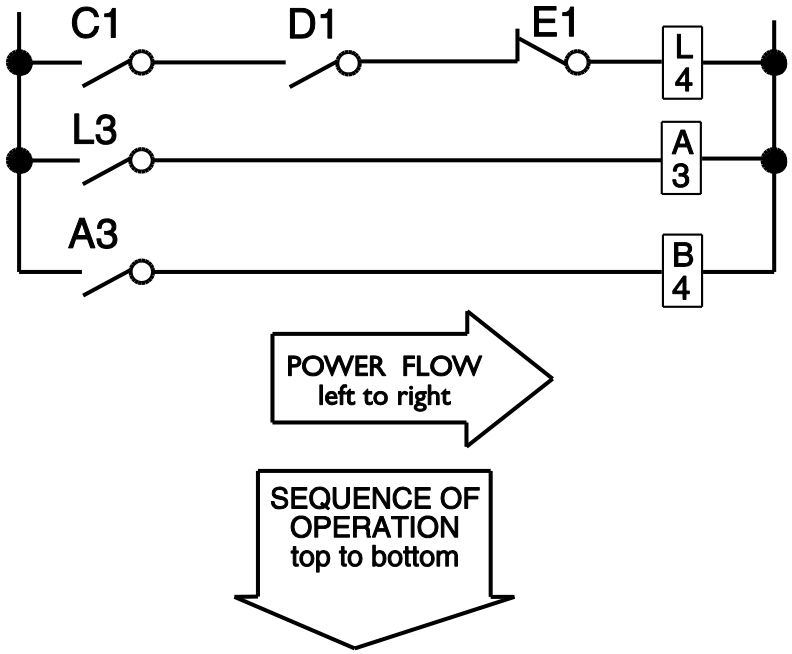


Fig. PF-4-1-29– Horizontal Circuit Arrangement

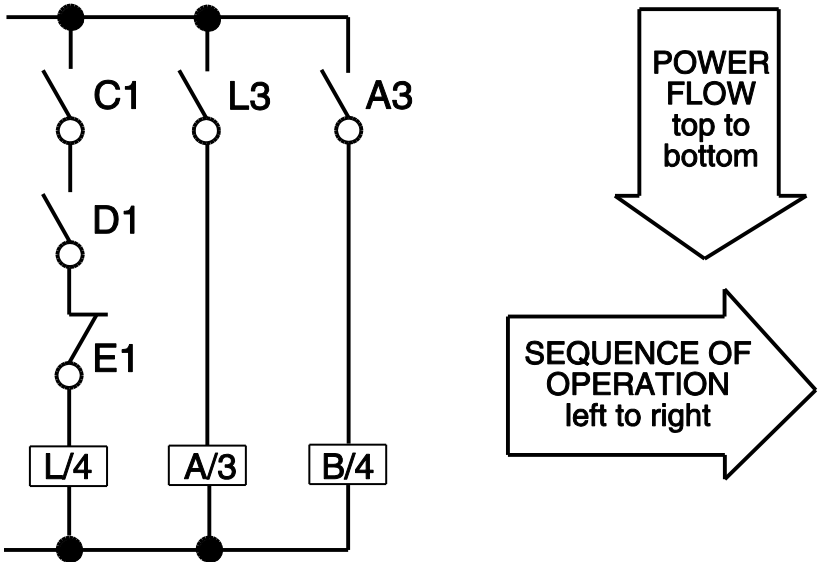


Fig. PF-4-1-30– Vertical Circuit Arrangement

CIRCUIT DIAGRAM DRAWING CONVENTIONS

- Lines indicating the power (heavier current carrying) conductors are drawn thicker than the lines indicating the control part of the circuit.

Crossing and Joined Conductors

- Conventions for crossing and joined conductors are shown below

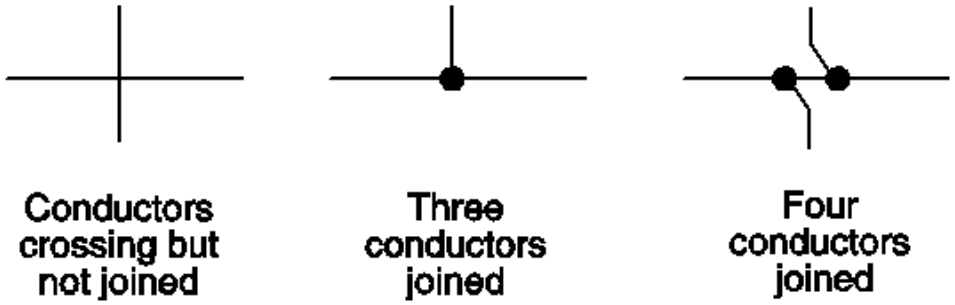


Fig. PF-4-1-31– Conductors Crossing and Joined

CIRCUIT DIAGRAM DRAWING CONVENTIONS

- Circuit diagrams are always drawn in the condition that would exist if power was *not* applied.
- This simplifies the task of determining the sequence of operation once power is applied.

Standard circuit symbols

- Standard circuit symbols can be found in *AS/NZS 1102:102* . A selection of commonly used circuit symbols is in **Table PT-4-1-7** .

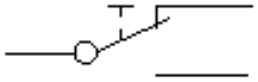
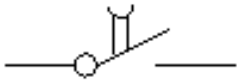
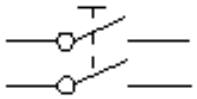
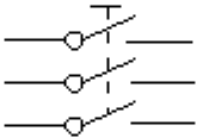
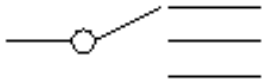
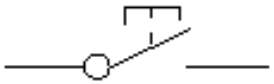
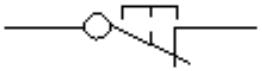
	Manually operated, single throw, double pole switch
	Time delay switch
	Circuit breaker
	Double pole switch (manually operated-normally open)
	Triple pole switch (manually operated-normally open).
	Single pole 3 position switch
	Normally open push button switch
	Normally closed push button switch
	Emergency switch

Table PT-4-1-7– Commonly Used Circuit Symbols

WIRING DIAGRAMS

- A wiring diagram is a detailed diagram showing the manner in which a circuit or system is actually wired and assembled.
- Wiring diagrams show terminal positions, often identified by numbers, and indicate which wire should be connected to which terminal.
- **Figure PF-4-1-32** is an example of a simple wiring diagram. The circuit consists of two lighting points independently controlled by separate switches.

WIRING DIAGRAMS

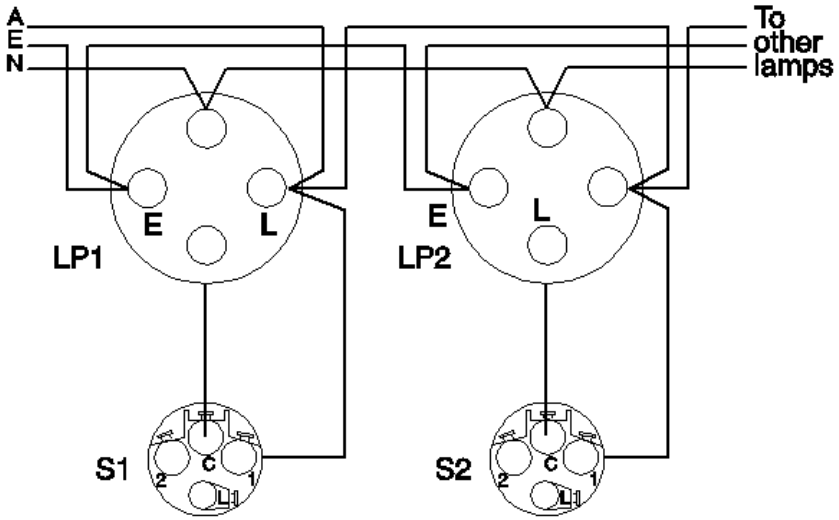


Fig. PF-4-1-32– Simple Wiring Diagram

- The purposes of a wiring diagram are:
  - to construct, wire or modify a circuit
  - to specify all necessary connections, cable colour, size and type
  - to help in fault finding,

THE SINGLE LINE DIAGRAM

- In power engineering, a one-line diagram or single-line diagram is a simplified notation for representing a three-phase power system.
- Electrical elements such as circuit breakers, transformers, capacitors, bus-bars, and conductors are shown by standardised schematic symbols.
- Instead of representing each of three phases with a separate line or terminal, only one conductor is represented.

THE SINGLE LINE DIAGRAM

- The single-line diagram is a form of block diagram graphically depicting the paths for power flow between entities of the system.

THE SINGLE LINE DIAGRAM

- A typical one-line diagram with annotated power flows is shown in **Fig. PF-4-1-33** :
  - Red boxes represent circuit breakers
  - grey lines represent three-phase bus and interconnecting conductors
  - the orange circle represents an electric generator,
  - the green spiral is an inductor, and
  - the three overlapping blue circles represent a double-wound transformer with a tertiary winding.

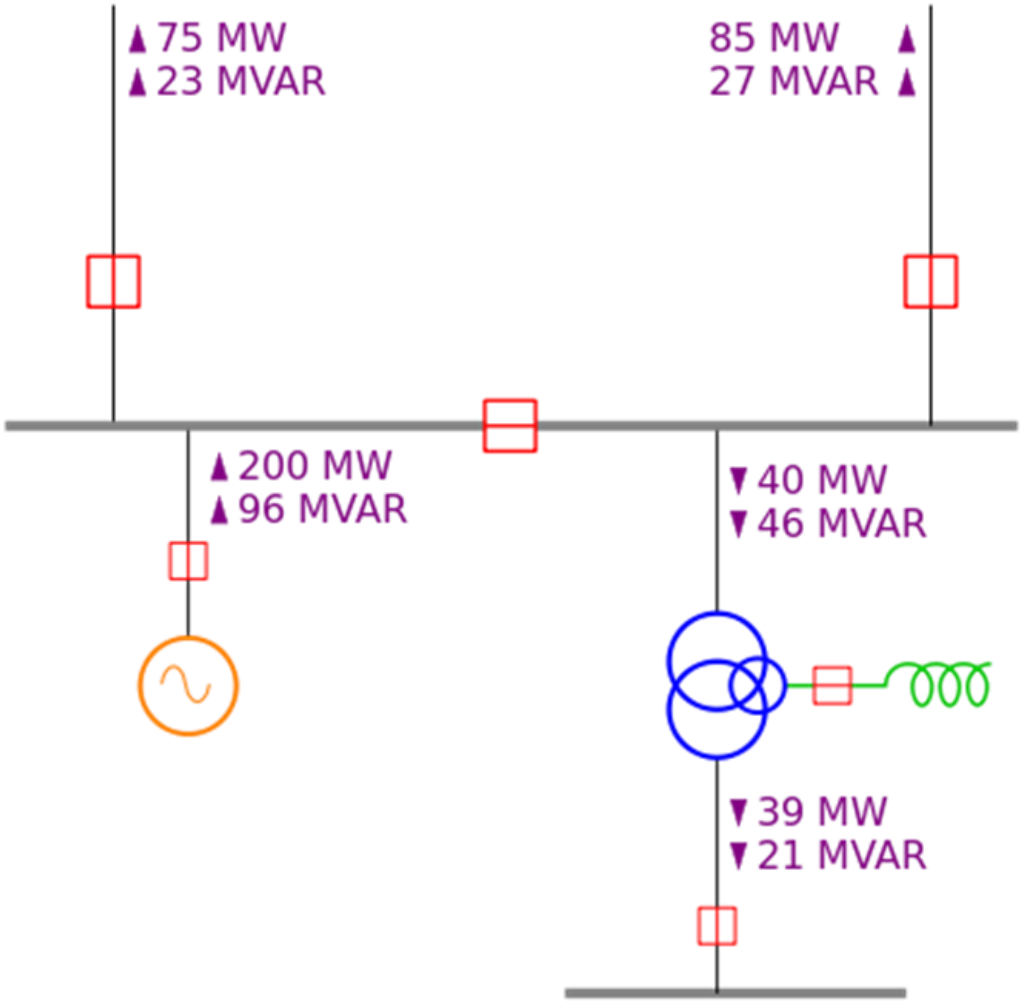


Fig. PF-4-1-33 A typical single-line diagram with annotated power flows.

- Red boxes represent circuit breakers,
- grey lines represent three-phase bus and interconnecting conductors,
- orange circle represents an electric generator,
- green spiral is an inductor,
- the three overlapping blue circles represent a double-wound transformer with a tertiary winding.

ELECTRICAL SCHEDULES

- Electrical schedules are used and read in conjunction with electrical layout plans, single line diagrams or wiring diagrams.

ELECTRICAL SCHEDULES

- Schedules may be produced in a variety of forms, for example:
  - cable schedule - provides specific details related to cable installation
  - outlet schedule - lists specific details regarding outlets, lighting points, etc
  - appliance schedule - details specific requirements related to the installation of appliances and equipment.
  - switchboard schedule – identifies circuits supplied from the switchboard (note that some form of circuit identification is mandatory under (AS/NZS 3000:2007)

ELECTRICAL SCHEDULES

- A schedule details supplementary information to the electrical specification and the diagram that it is read in conjunction with.
- A schedule is prepared in the form of a table with column headings that vary with the type of installation.
- A cable schedule can be used to provide any of the following items of information related to the installation of a cable or cables:

ELECTRICAL SCHEDULES

- type
- colour
- size
- length
- voltage rating
- conductor function
- screening
- connection points (origin and termination)
- route
- cable or wire number
- special installation requirements

ELECTRICAL SCHEDULES

- **Table PT-4-1-8** shows a simple example of a cable schedule that is read in conjunction with the wiring diagram shown in **Figure PF-4-1-34**.

Wire				Connection	
No.	**Colour**	**Size**	**Type**	**From**	**To**
12	RD (Red)	1.0 mm^2	TPI (Thermo-Plastic Insulated)	TB1:A (Terminal Block 1, Terminal A	TB2:A
13	BK (Black)	1.5 mm^2	TPI	TB1:B	TB2:C
14	RD	1.5 mm^2	TPI	TB1:C	TB2:D
15	WH (White)	2.5 mm^2	TPI	TB1:D	TB2:F
16	BU (Blue)	1.5 mm^2	TPI	TB1:E	TB2:B
17	YL (Yellow)	1.0 mm^2	TPI	TB1:F	TB2:E

Table PT-4-1-8– Cable Schedule

ELECTRICAL SCHEDULES

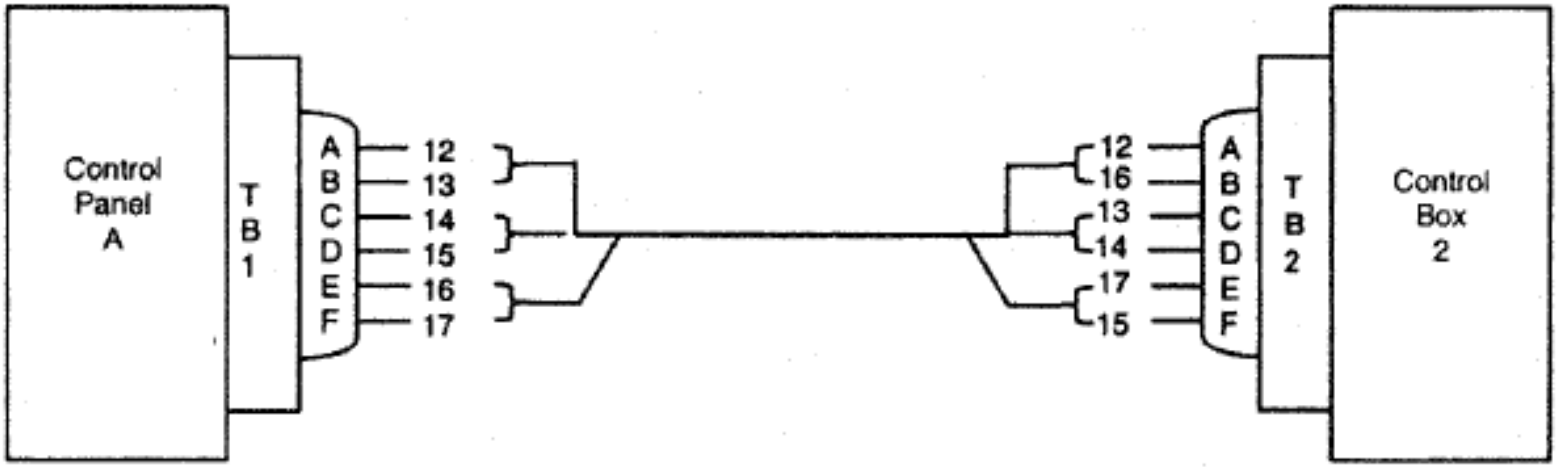


Fig. PF-4-1-34 Wiring Diagram

- Schedule are usually supplemented with a diagram to show equipment layout information, such as the relative location of items, terminal arrangement, etc.

Topic 4-2

SPECIFICATION WRITING

ENPRA101A – Engineering Practices

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INTRODUCTION

- The specification is a document which clearly, accurately and completely describes the essential requirements of the goods or service being procured.
- The success of a procurement activity (for goods or services) relies on the specification being a true and accurate statement of the buyer's requirements.
- A specification will form part of any future contract that might result from offers received.

ELEMENTS OF A SPECIFICATION

- A specification should:
  - state the requirement clearly, concisely and logically
  - for goods, state what the item will be used for;
  - contain enough information for tenderers to estimate the cost of the goods or services they will offer and at what level of quality;
  - permit offered goods or services to be evaluated against defined criteria by examination, trial, test or documentation;
  - state the criteria for acceptance of goods or services by examination, trial, test or documentation;

ELEMENTS OF A SPECIFICATION

- A specification should: (Cont'd)
  - provide equal opportunity for all potential suppliers to offer goods or services which satisfies the needs of the user, including alternative solutions;
  - form the fundamental basis of the contract between buyer and seller;
  - not over-specify requirements; and
  - It should be noted that specifications involving the expenditure of public money may have additional elements, for example the requirements for locally manufactured goods or locally based contractors

BRAND NAMES

- It’s usually easier to nominate a brand name of an item rather than to specify an acceptable functional performance and/or technical standards.
- However it is not acceptable practice to routinely specify brand names.
- Where brand names are used to define the requirements, locally manufactured or NZ products should, where practicable, be specified.
- At the same time the specification should also invite offers of equivalent products

BRAND NAMES

- The priority order for specifying products is:
  1. Function, performance, technical specification;
  2. Aust. or NZ manufactured brand name(s), or equivalent product when “1” (above) is not practicable;
  3. Overseas brand names, or equivalent product, when specification under “1” and “2” (above) is not practicable.

TYPES OF SPECIFICATIONS

There are three types of specifications:

(A) Functional Specifications

- These are specifications that define the function, duty or role of the goods or services.
- They nominate what the goods or services are broadly required to do.
- They define the task or desired result by focussing on what is to be achieved rather than how it is to be done.
- They do not describe the method of achieving the intended result.
- This enables suppliers to provide solutions

TYPES OF SPECIFICATIONS

(B) Performance Specifications

- These are specifications that define the purpose of the goods or services in terms of how effectively it will perform that is, in capability or performance terms
- The performance specification is the logical extension of a functional specification.
- Performance specifications define the task or desired result by focussing on what is to be achieved.
- They do not describe the method of achieving the desired result, but are more stringent in defining performance parameters than the functional specification

TYPES OF SPECIFICATIONS

(C) Technical Specifications (also known as "Conformance" or "Detail" Specifications)

- These are specifications that define the technical and physical characteristics of a product, such as , dimensions, colour, surface finish, design details, material properties, energy requirements, processes, maintenance requirements, operational requirements etc.
- They are used when functional and performance characteristics are insufficient to define the requirement.

TYPES OF SPECIFICATIONS

(C) **Technical Specifications** (Cont'd)

- Note: Another way of doing this is to simply quote a catalogue or model number of an item that already exists, although this method may contravene purchasing policy of government and semi-government organisations.

PREFERENCE TO FUNCTIONAL AND PERFORMANCE SPECIFICATIONS

- All three types of specifications may be combined to form the one specification.
- Functional and performance specifications are preferred because:
  - Suppliers can offer alternative and innovative ideas and solutions
  - tenderers can focus on providing the best solution; and
  - the focus on outcomes should result in better value for money.

SIMPLE REQUIREMENTS

At times simple requirements can be better defined in technical terms. A simple description may be issued in a number of ways such as:

(A) Exemplar Specification

- This gives an example of a known product or service which would be appropriate and allows for alternatives by including the words “or equivalent” or “or similar”.
- This is used when the equipment is genuinely necessary and does not reflect a bias towards particular items or suppliers.
- Reasons for specifying the nominated items must be given.

SIMPLE REQUIREMENTS

(B) Samples

- For some products it may be necessary to supply an actual example of the item required by the customer to the supplier.
- Suppliers must produce goods that are identical in all respects to the sample.
- Samples should only be used in appropriate circumstances with a complementary specification.

SIMPLE REQUIREMENTS

(C) Drawings

- Drawings can be used in a specification as technical description or to provide guidance to tenderers.
- Drawings in specifications involve risk.
- Requesting a supplier to produce an item to a drawing or set of plans is like nominating a brand name: the manufacturer is largely absolved of responsibility if the item does not work.
- There are contractual clauses to cover this eventuality, but the use of drawings as a specification generally requires the buyer to bear most of the risk of things going wrong.

EVALUATION CRITERIA

- Whatever methods are used to define the goods or services, there must be criteria to evaluate compliance of offers with the specification.
- Such evaluation criteria should be developed at the same time as developing the specification.
- This may be holistic evaluation incorporating , price, delivery, warranty, or compliance may be a “pass” or “fail” to meet the mandatory requirements. Value for money may then be assessed on other variables.

DEVELOPING A SPECIFICATION

Step 1: Planning and Analysis

- Engaging key people
- Analysing and defining requirements
- Thinking of possible solutions
- Possible Value Analysis study

Step 2: Consultation and Information Gathering

- Liaison between the end-user, technical staff ,project managers, specification writer and any other stakeholders including local, state, and federal authorities.

DEVELOPING A SPECIFICATION

Step 3: Writing the specification

- Use simple, clear language without jargon (to minimise misinterpretation).
- Define terms, symbols and acronyms (include a “Glossary of Terms”).
- Be concise.
- Do not explain the same requirement in more than one section.
- Define each aspect of the requirement in one or two paragraphs where possible.
- Adopt a user-friendly format.

DEVELOPING A SPECIFICATION

Step 3: (Cont'd)

- Number the sections and paragraphs.
- Seek feedback from someone unfamiliar with the requirement.
- Discuss the draft and refine it.
- There are no fixed rules on formats and structures because each specification reflects a different requirement or need. A specification should list the functional, performance and technical characteristics separately.

DEVELOPING A SPECIFICATION

Step 4: Vetting the Specification and Obtaining Approvals

- Depending on the organisation that the specification author is working for, specifications normally require several stages of approval.
- These may involve the engineering manager, the finance manager, the client, and the specification writer
- As a final check it is worthwhile to have a disinterested third party read the specification to verify readability, simplicity of meaning, clarity, and logic.

DEVELOPING A SPECIFICATION

Step 5: Issuing the Specification

- The specification should be included as part of the ***"Invitation to Tender"*** document.
- The "Invitation to Tender " should target suppliers that are capable of meeting the specification by direct approach (after market analysis) or through advertising in newspapers, websites and industry magazines, etc.

Step 6: Managing Amendments to the Specification

- All tenderers or potential tenderers must be given a reasonable opportunity to offer to the new specification.
-

DEVELOPING A SPECIFICATION

Step 7: Revising and Storing the Specification

- The specification should be reviewed at the end of the purchasing activity to ensure that it effectively defined the goods or services that were actually bought.
- If areas for improvement are identified, revise the specification with the benefit of hindsight.
- When the review of the specification has been completed and satisfactory , it should be kept on file.

INFORMATION THAT SHOULD BE INCLUDED IN A SPECIFICATION

The following is a list of topics commonly included in a specification but is by no means an exhaustive list:

- Title
- Table of contents
- Introduction
- Scope
- Background information or history of the required goods and services.
- List of terms, symbols and acronyms (Glossary)
- List of relevant documents

INFORMATION THAT SHOULD BE INCLUDED IN A SPECIFICATION

List of topics in a specification (Cont'd):

- External approvals
- Security aspects
- Environmental and ergonomic limitations
- Detailed requirements
- Whole-of-life support
- Marking of supplies
- Preservation and packaging
- Quality requirements
- Testing


END