Electrical Drawings and Schematics

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Electrical Drawings and Schematics

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Engineering Drawings for Electrical Engineers – An Introduction

This chapter explains the need for the development of engineering drawings as part of the problem solving for the engineers and their relevance to the various departments of an engineering organization. It also explains the various steps involved in the development of drawings; their release and control with reference to the accepted standards.

Learning objectives

- To provide the reader with an overview of the relevance of drawings in an engineering environment and the purpose served by different types of drawings.
- To familiarize the reader briefly with the history of origin of worldwide standards in electro technology and also the standards and procedures usually followed by organizations for development and control of drawings.

1.1 Drawings – their relevance to engineering

One of the most effective ways of communicating one's ideas is through drawings or graphics. For many years various types of drawings, sketches and paintings have been used to convey ideas and information. A good recognizable picture reduces ambiguity while discussing a project. The two basic skills required by an engineer are: to plan the work and then to work the plan. Engineers and technical personnel associated with an engineering organization use drawings to convey graphically the ideas and plan necessary for execution and completion of a project involving construction or assembly of components or systems.

1.1.1 Drawings as a tool for problem solving

The drawings help the engineering process problem solving in the following ways:

- It provides the geometric form of the design.
- It acts as a communication tool between the designers and the manufacturing/construction personnel.
- It acts as an analysis tool and helps decide and calculate some of the unknown dimensions and tolerances.
- It acts as a design simulator.
- It checks the completeness of the design and helps the designers identify the missing parameters.

1.1.2 Drawings as a tool used at various stages of working in an organization

The drawings help the engineering organization during the various stages as mentioned below:

- Tendering stage: It helps in transforming the needs of the client into the world of the designer. It helps in procuring an accurate quote and also helps in avoiding future disputes arising out of discrepancies due to lack of information.
- Design and engineering stage: The drawings at the designing stage are a tool for data representation for the design engineers as the designer conveys the information in the form of design. During detailed engineering stage the drawing helps the engineers work out the detailed bill of materials which is further used by the procurement department.
- Construction or assembly stage: The drawings in this stage help the technical personnel at the construction site or the assembly shop in carrying out the process smoothly and with minimum ambiguity.
- Operation and maintenance stage: At this stage the drawings are the key help for the day to day operation and maintenance for the technicians. It helps them identify any anomaly occurring in the system quickly and carry out the rectifications.

1.1.3 Drawings at the centre of the various activities of an engineering organization

The drawings are at the centre of activities taking place in an engineering organization whether a manufacturing organization or a turnkey contracting organization. The cycle of activities taking place in a manufacturing organization is explained in Figure 1.1 and the cycle of activities taking place in a contracting organization is explained in Figure 1.2.

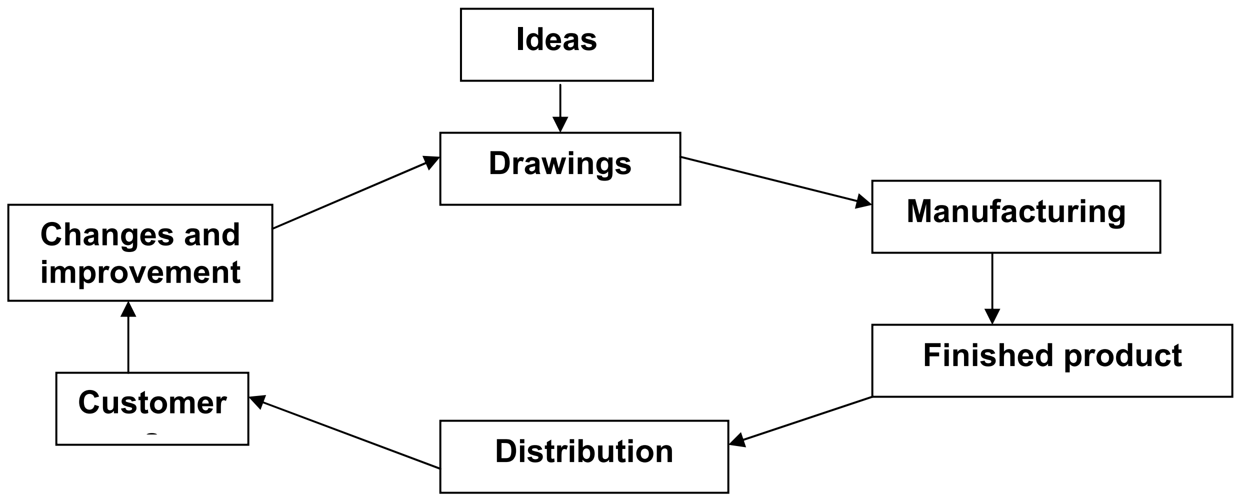


Figure 1.1
Cycle of activities in a manufacturing organization

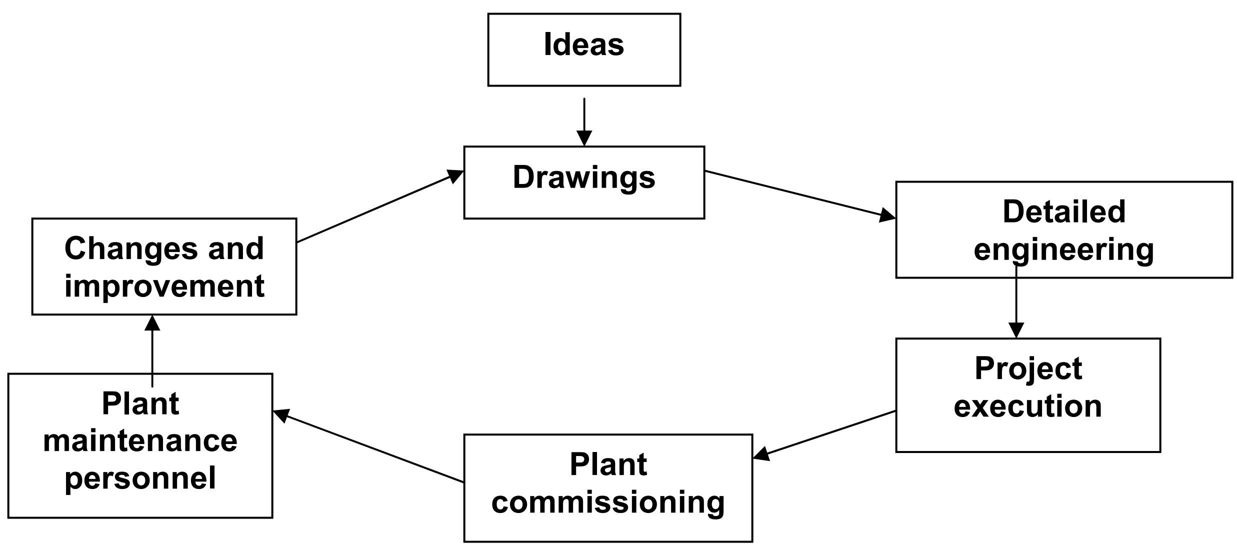


Figure 1.2
Cycle of activities in a construction organization

1.2 Origin of worldwide standards in electro-technology

The nineteenth century saw major technological inventions in the field of electro-technology. Before this period although the units of measurement for electrical parameters had been established, the standardization of the electrical equipments had not taken place with the result that it was difficult for the manufacturers, users and local authorities to make comparison between products of the same type. Manufacturers also felt that for repetitive productions some sort of design codes were necessary and also some sort of quality guaranteeing institution was needed to guarantee their products for reducing competition in the local and the international market.

1.2.1 Standards and their necessity

- Market growth for new and emerging technologies
- Reduced development time and cost
- Sound engineering practices
- Decreased trading costs and lowered trade barriers
- Increased product quality and safety
- Reduced market risks
- Protection against obsolescence

With these ideas countries in the different parts of the world started forming their own standardizing bodies. Examples are ANSI, BS, AS, DIN, etc. Also some of the industry-bodies formulate standards specific to those industrial segments. Examples are NEMA, API, IEEE, VDE, etc.

In engineering drawings too, standards had to be established to ensure that a drawing can be read and understood by anyone who uses it by adopting a common set of symbols and terminology. Moreover, standards are necessary to make a drawing presentable and easy to read by adopting proper arrangement of information on a sheet, appropriate sheet sizing, applying proper scaling, use of correctly-sized lettering for text and dimension markers, legends and bill of materials information, title contents and so on. While some of the above features are specific to the company, which makes a drawing, others need to be standardized across the entire industry. Such common standards have been evolved by the International Standards Organisation (ISO) and International Electro-technical Commission (IEC) and are adopted widely by the engineering industry the world over.

A brief description and constitution of the major standardizing bodies representing electrical and allied disciplines is given below.

Institution of Electronic and Electrical Engineers (IEEE)

With nearly 1,300 standards either completed or under development, IEEE is a central source of standardization in both traditional and emerging fields, particularly telecommunications, information technology and power generation.

National Electrical Manufacturers Association (NEMA)

It provides a forum for the standardization of electrical equipment, enabling consumers to select from a range of safe, effective, and compatible electrical products.

Association of German Electrical Engineers (VDE)

The VDE is the German Association for Electrical, Electronic and Information Technologies, a professional body based in Frankfurt. The role of the VDE in Germany is comparable to that of the IEEE in the US. Its main activity is as a standards organization.

International electro-technical Commission (IEC)

The International Electro technical Commission (IEC) is the leading global organization that prepares and publishes international standards for all electrical, electronic and related technologies. These serve as a basis for national standardization and as references when drafting international tenders and contracts. ISO (the International Organization for Standardization) and IEC (the International Electro technical Commission) form the specialized system for worldwide standardization.

International Standards Organisation

ISO is a network of the national standards institutes of 157 countries, on the basis of one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system. ISO is a non-governmental organization: its members are not delegations of national governments. Many of its member institutes are no doubt part of the governmental structure of their countries, or are mandated by their government but other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations.

1.3 Purposes served by different types of drawings

Technical drawings are used to convey a large amount of exact, detailed information in an abbreviated language. They consist of lines, symbols, dimensions, and notations to accurately convey an engineer's designs to electricians/technicians who install the electrical system on a job. Technical drawings are used to convey a large amount of exact, detailed information in an abbreviated language. They consist of lines, symbols, dimensions, and notations to accurately convey an engineer’s designs to electricians/technicians who install the electrical system on a job.

The types of technical drawings used for any project can be broadly categorized as two-dimensional and three-dimensional drawings.

1.3.1 Two dimensional drawings

Typical examples of two dimensional drawings are as below.

Drawings showing key plan and plan/layout of buildings, facilities and services

Most plants are large enough that a key plan is needed to show where the work will be performed. If there is room on the index sheet, this is a good place to show this information. It is also beneficial to have an overall dimensioned plant drawing, showing how to get to the work area. Major landmarks in the plant should be shown and identified. Many times, this brings up discussions on proximity to high-voltage lines or pipelines, permits required, and the logistics of getting the equipment into the room or the plant. Individual floor plans for respective areas in a plant are also prepared for providing further details of each area.

Drawings with structural design details

These are done on the basis of calculation of member dimensions to examine safe operation of structure. These consist of all the drawings that describe the structural members of the building and their relationship to each other. A set of structural drawings includes foundation plans and details, framing plans and details, wall sections, column and beam details, and other plans, sections, details, and schedules necessary to describe the structural components of the building or structure. The general notes in the structural drawings should also include, when applicable, roof, floor, wind, seismic, and other loads, allowable soil pressure or pile bearing capacity, and allowable stresses of all material used in the design. Please refer to Figure 1.3 for example of a structural drawing.

Machine parts design and fabrication drawings

These are also called machine drawings. These are principally found in and around machine and fabrication shops where the actual machine work is performed. The drawing usually depicts the part or component as an orthographic projection with each view containing the necessary dimensions.

Section drawings

In situations where objects have intricate interior details, and hidden lines do not sufficient clarity, section drawings are used. In such a case the object is imagined being cut or sectioned by planes. The part of the object between the cutting plane and the observer is assumed to be removed and the view is shown in the section drawing. Please refer to Figure 1.4 for example of a section drawing.

Clearance drawings

Clearances are critical for any engineering equipments, parts and modules for the safe and optimum functioning of these parts. These drawings provide details of clearance required while installation/fabrication. Please refer to Figure 1.5 for example of clearance drawing provided for a power module.

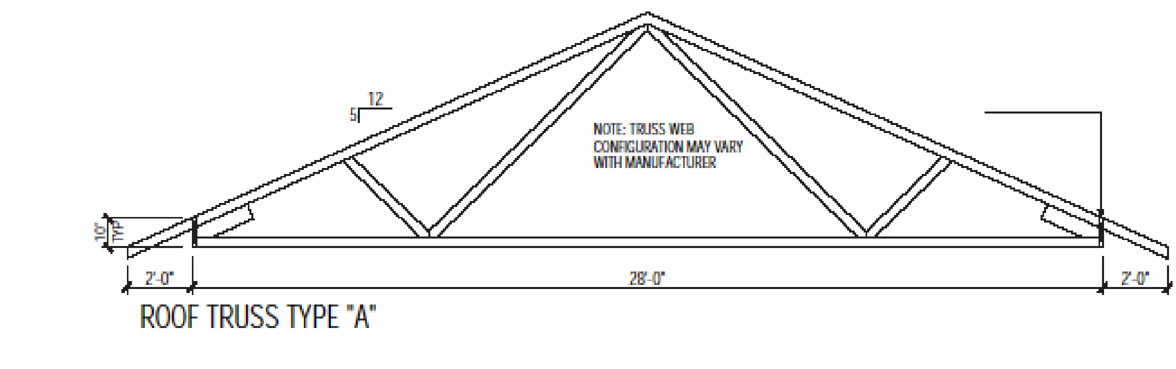


Figure 1.3
Example of structural drawing

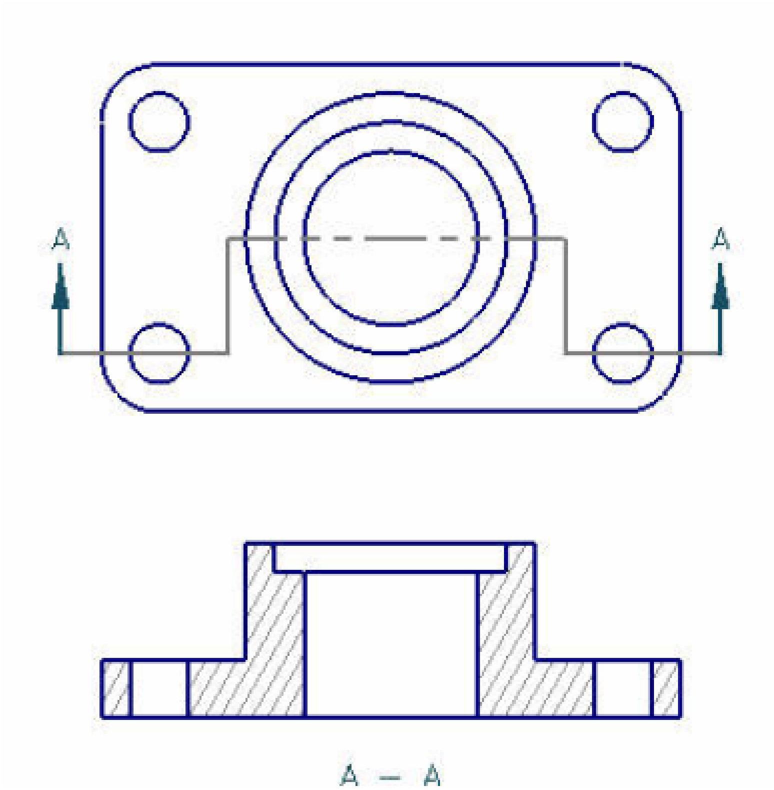


Figure 1.4
Example of section drawing

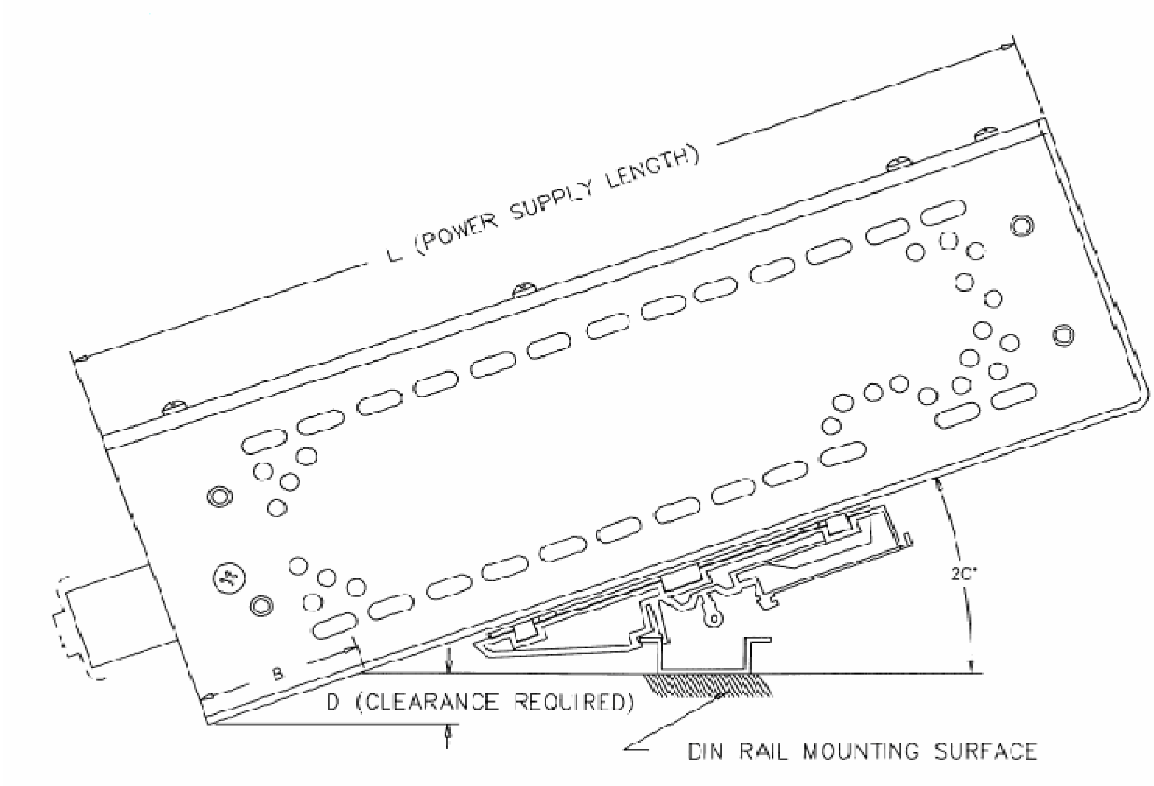
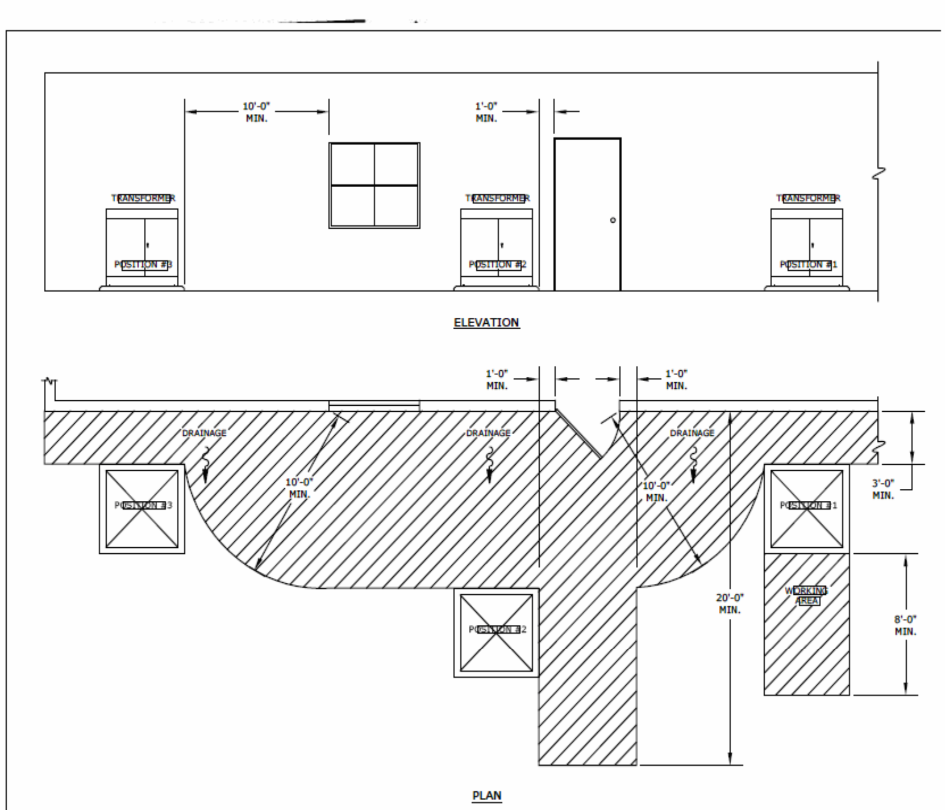


Figure 1.5 (a)
Example of clearance drawing for a power module



NOTES:

POSITION 1 - CLEARANCE TO FIRE RESISTANT CONSTRUCTION:
HORIZONTAL CLEARANCE: 3'-0" MIN. TO BUILDING.
VERTICAL CLEARANCE: TO COMBUSTIBLE OVERHANG IS 30'-0" MIN.
WORKING CLEARANCE: 8'-0" MIN. IN FRONT.
FENCED ENCLOSURE CLEARANCE: 2'-0" BACK & SIDES.

POSITION 2 & 3 - CLEARANCE TO COMBUSTIBLE OR UNPROTECTED POINTS (DOORS OR WINDOWS):
HORIZONTAL CLEARANCE: 10'-0" MINIMUM.
VERTICAL CLEARANCE: TO COMBUSTIBLE OVERHANG IS 30'-0" MIN.
WORKING CLEARANCE: 8'-0" MIN. IN FRONT.
FENCED ENCLOSURE CLEARANCE: 2'-0" BACK & SIDES.
DOOR CLEARANCE: 10'-0" MIN. FROM DOOR, 1'-0" OFFSET (EGRESS BLOCKING). 20'-0" MIN. FROM DOOR FRONT.

DRAINAGE:
ARRANGE DRAINAGE OR PROVIDE CURBS SO THAT TRANSFORMER OIL CANNOT FLOW TOWARDS THE BUILDING.

REFERENCES:
CALIFORNIA ELECTRICAL CODE, 450-27.

Figure 1.5 (b)
Example of clearance drawing for a transformer

Various types of schematics, wiring diagrams and tables/schedules

Electrical drawings are mostly covered in this category (e.g. motor control schematics, wiring diagrams) and text tables/schedules such as cable schedule, lighting schedule, etc. We shall study these in greater detail in the subsequent chapters.

1.3.2 Three dimensional representations

Three dimensional representations can be further classified as:

Isometric views: In isometric views, all lines on each axis are parallel to each other, and the lines do not converge. Such drawings are commonly used in technical illustrations of:

- Machine parts (please refer to Figure 1.6).
- Exploded views for machine parts where enlarged view of various micro parts are provided (please refer to Figure 1.7)
- Piping schematics and hook-ups.

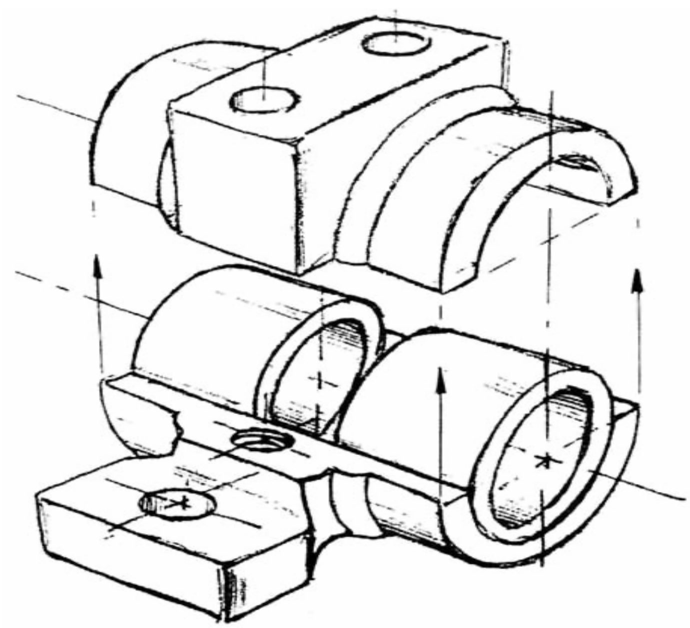


Figure 1.6
Example of isometric drawing for a machine part

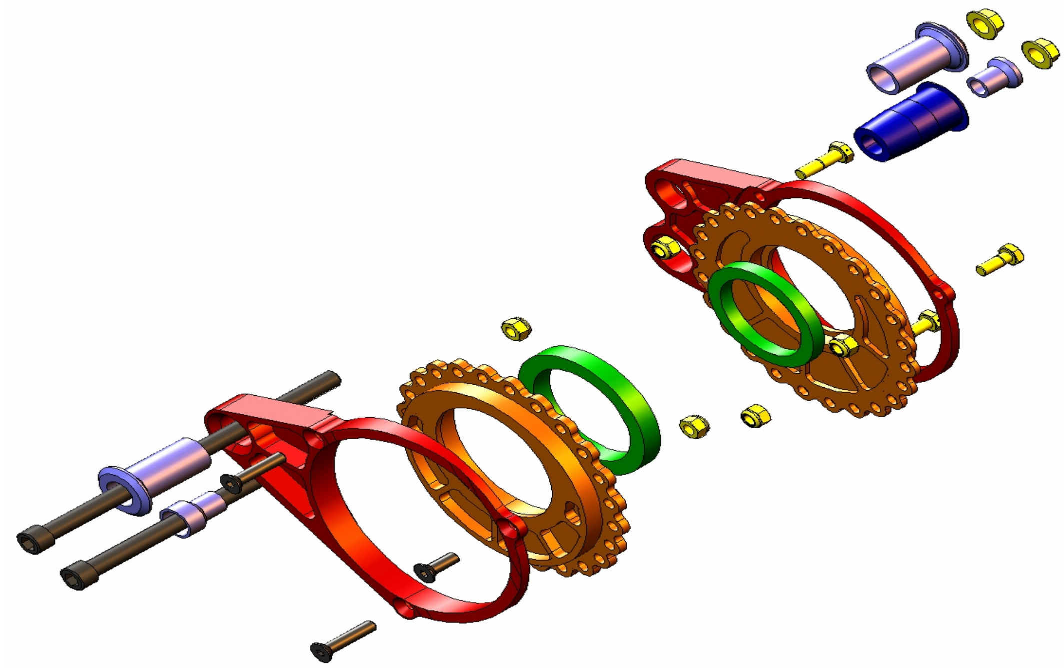


Figure 1.7
Example of exploded view for a bearing mounting assembly

Perspective views: A perspective view portrays height, width and depth. This allows the viewer to get a more realistic graphic. All lines in a perspective drawing seem to converge in a vanishing point and the drawn objects appear proportionately smaller with distance. These are used for:

- Displaying architectural views of plants and buildings.
- Computer generated walk through for buildings and architectures.

Solid and surface models: These are used for visualization, analysis and manufacture of complex parts. Typical examples are:

- Wireframe models: these are sculptured models of machine parts. The part is digitized using solid scanning or point to point scanning with a three co-ordinate measuring machine which generates a wire mesh. This wire mesh is further put into CAD for generating a 3D model having geometrical co-ordinates. This 3D model is sent to numerically controlled model making machines for generating the digitized pattern,
- Solid model: is the representation of the solid parts of an object, that is, models of solid objects suitable for computer processing. It is also known as volume modeling A solid model generally consists of a group of features, added one at a time, until the model is complete A solid object is represented by boundary surfaces and then filled to make solid. It is analogous to the process of casting in manufacturing techniques.

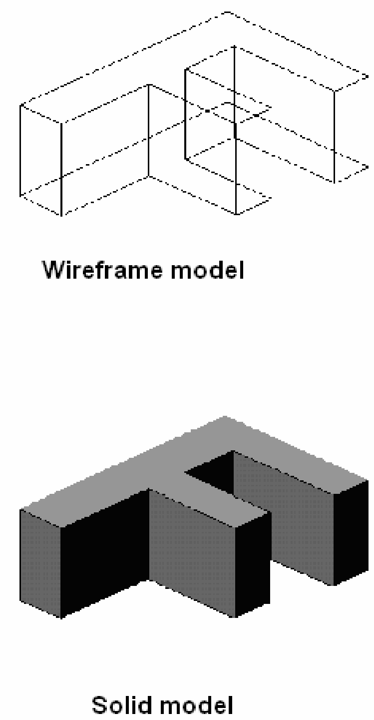


Figure 1.8
Example o f wireframe model and solid model

1.4 Standards in a drawing office

1.4.1 Introduction

The drawing office is considered to be the heart of any engineering organization. Ideas, layouts, schemes and designs worked out by an engineer in the form of a rough sketch, are developed into the drawing stage by stage by the draughtsman. The other departments can do very little within an engineering organization without an approved drawing. The drawing is the universal means of communication.

It is necessary to impose appropriate standards at the drawing stage since all manufacturing instructions originate from this point.

A perfect drawing communicates an exact requirement, or specification which cannot be misinterpreted at a later stage and lead to problems after execution.

Engineering drawings can be produced to a good professional standard if the following points are taken care of:

- Uniformity of graphical depiction is maintained.
- Only necessary information is displayed on the drawings.
- Correct dimensioning is done.
- Only standard symbols and abbreviations are used.

Good communication by the use of drawings of quality relies on ensuring that they confirm to established standards.

1.4.2 Important standards used in drawing office

The standards commonly used by design offices are those shown in Table 1.1.

Table 1.1
International standards for drawing office

Serial Number	Standard number	Title
1	ISO 128	Technical drawings – General principles of presentaton
2	ISO 129	Technical drawings - dimensioning
3	ISO 216	Paper sizes
4	ISO 406	Technical drawings –Tolerancing of linear and angular dimensions
5	ISO 1101	Technical drawings – Geometrical tolerancing
6	ISO 1660	Technical drawings – Profile dimensioning
7	ISO 3040	Technical drawings – Cone dimensioning
8	ISO 3098/1	Technical drawings - Lettering
9	ISO 5455	Techical drawings - scales
10	ISO 5459	Technical drawings – Datum systems for geometric tolerancing
11	ISO 6410	Technical drawings – representaion of threaded parts
12	IEC 60617-2:1996	Graphical symbols for diagrams. Symbol elements, qualifying symbols and other symbols having general application
13	IEC 60617-3:1996	Graphical symbols for diagrams. Conductors and connecting devices
14	IEC 60617-4:1996	Graphical symbols for diagrams. Basic passive components
15	IEC 60617-5:1996	Graphical symbols for diagrams. Semiconductors and electron tubes
16	IEC 60617-6:1996	Graphical symbols for diagrams. Production and conversion of electrical energy

Serial Number	Standard number	Title
17	IEC 60617-7:1996	Graphical symbols for diagrams. Switchgear, controlgear and protective devices
18	IEC 60617-8:1996	Graphical symbols for diagrams. Measuring instruments, lamps and signalling device
19	IEC 60617-9:1996	Graphical symbols for diagrams. Telecommunications. Switching and peripheral equipment
20	IEC 60617-10:1996	Graphical symbols for diagrams. Telecommunications. Transmission
21	IEC 60617-11:1996	Graphical symbols for diagrams. Architectural and topographical installation plans and diagrams
22	IEC 60617-12:1997	Graphical symbols for diagrams. Binary logic elements
23	IEC 61082-1:1991	Preparation of documents used in electrotechnology. General requirements
24	IEC 61082-2:1993	Preparation of documents used in electrotechnology. Function-oriented diagram
25	IEC 61082-3:1993	Preparation of documents used in eletrotechnology. Connection diagrams, tables
26	IEC 61082-4:1996	Preparation of documents used in electrotechnology. Location and installations

1.4.3 Sizes of drawing sheets

The preferred size of drawing sheets is taken from the ISO-A series which is listed in Table 1.2.

However, under certain circumstances the use of other drawing sheet sizes may be necessary and the ISO-B series sheets may be used. Roll drawings when required should have standard widths of either 86mm or 610mm.

Table 1.2
Sizes of drawing sheets (A-Series as per ISO 216)

Designation	Trimmed size (mm)	Width of border (mm)
A0	841 X 1189	20
A1	594 X 841	20
A2	420 X 594	15
A3	297 X 420	15
A4	210 X 297	15

1.4.4 Thickness of format lines

Recommended line thicknesses in mm for format lines are as per Table 1.3.

Table 1.3
Thickness of format lines

Feature	A0 Sheet	A1 sheet	A2,3,4 sheet
Border lines	1.4 mm	1.0 mm	0.7 mm
Title block lines	1.00 mm	0.7 mm	0.5 mm
Grid lines	0.7 mm	0.5 mm	0.35 mm
Fold lines	0.25 mm	0.25 mm	0.25 mm
Other format lines	0.35 mm	0.25 mm	0.18 mm

1.4.5 Thickness of drawing lines

The thickness of drawing lines is covered in details in the standards and is based on line group types which may be 1.0, 0.7 and 0.5mm (line group 1.0 mm typically used on A0 sheet size) through to 0.35, 0.25 and 0.18 mm (line group 0.35 mm which may be more appropriate for A4 sheets. The standards specifically state that the minimum line thickness on a drawing after reproduction (including reduction) should not be less than 0.18 mm.

1.4.6 Text types and character heights

The following text types are provided in the drawing standards.

- Upright gothic
- Sloping gothic
- ISO 3098/1 Type B Upright
- ISO 3098/1 Type B Sloping
- Micro font

The height of the character should be one of the following (in mm) with minimum character line thickness not less than 10% of the height.

- 2.5 mm
- 3.5 mm
- 5 mm
- 7 mm
- 10 mm
- 14 mm
- 20 mm

The height of the characters should not be less than 1.7 mm on a reduced drawing reproduction.

1.4.7 Ratio of text size to corresponding line thickness

The ratio of line thickness to text size is generally 1:10 and one of the following sets of standard text sizes shown in Tables 1.4 and 1.5 with corresponding line thicknesses are often used.

Table 1.4
Text size versus line thickness

Text size (mm)	Line Thickness (mm)
1.8	0.18
2.5	0.25
3.5	0.35
5	0. 5
7	0.7
10	1.0

Table 1.5
Text size versus line thickness

Text size (mm)	Line Thickness (mm)
2.0	0.2
3.0	0.3
5.0	0.5
7.0	0. 7
10.0	1.0
14.0	1.4

1.4.8 Units for drawing dimensions

- Imperial units: This unit of measurement is based on feet and inches.
- SI units: This is based on the metric system and all dimensions are measured in millimeters.

Rules for using SI units:

- All fractional values must be preceded by a '0' (for example, 0.14mm).
- Neither comma nor spaces are used for values over 1000.

1.4.9 Drawing scales

All drawings can be classified as either drawings with scale or those not drawn to scale. Drawings without a scale usually are intended to present only functional information about the component or system. Prints drawn to scale allow the Figures to be rendered accurately and precisely. Scale drawings also allow components and systems that are too large to be drawn full size to be drawn in a more convenient and easy to read size. The opposite is also true. A very small component can be scaled up, or enlarged, so that its details can be seen when drawn on paper. Scale drawings usually present the information used to fabricate or construct a component or system.

1.4.10 Use of symbols in drawings

Many engineering devices and components cannot be drawn exactly as they appear physically and hence standard symbols are used to indicate such devices. Symbols should be neatly drawn, taking full advantage of the tools and modes available that ensure accuracy. Straight lines should really be straight, parallel lines should be parallel, square corners should be square, and so forth. Lines should meet neatly at corners, and there should be no stray marks that are part of the blocks.

1.5 Organization of a typical drawing office

The drawing office is a subset of the design office and as such the overall authority resides with the Resident Engineer and the Project manager. Their requirements and decisions are passed on to the drawing office staff via the Chief Draughtsman.

The function of the chief draughtsman is to take overall control of the services provided by the office. The chief draughtsman receives all the work coming into the drawing office which he examines and distributes to the appropriate section leaders. The section leader is responsible for a team of draughtsmen of different grades. When work is completed, the section leader passes the drawings to the checking section after which the standards section scrutinizes the drawings to ensure that the appropriate standards have been incorporated. All schedules, equipment lists and routine clerical work is normally performed by the technical clerk. Completed work for approval is done by the chief draughtsman.

Since the drawings may be produced manually, or by electronic methods, suitable storage, retrieval and duplication arrangements are necessary. Systems in common use include:

- filing by hand into cabinets the original master drawings, in numerical order, for individual components or projects;
- microfilming and the production of microfiche;
- Computer storage.

The structure of a design office is explained in Figure 1.9.

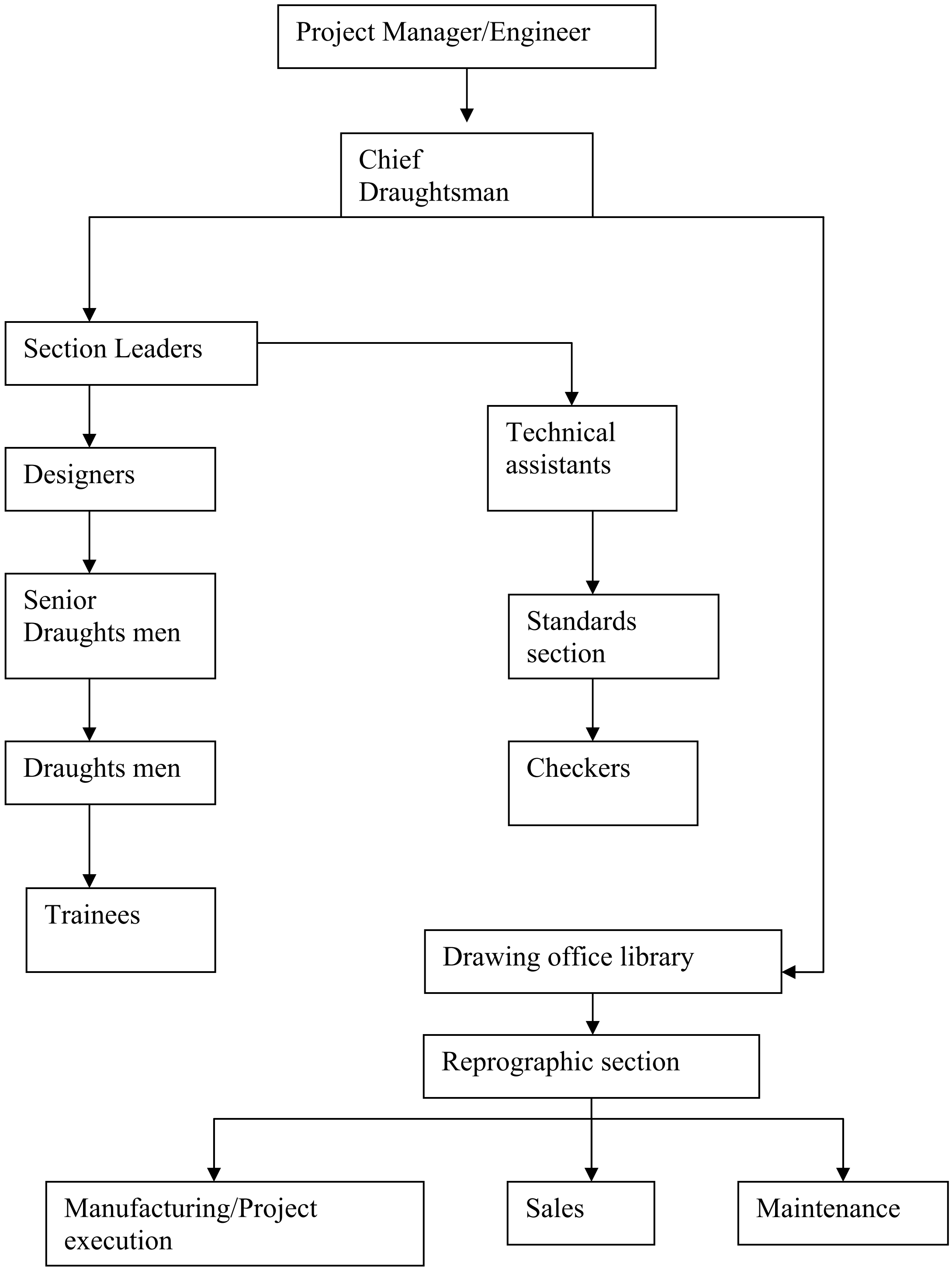


Figure 1.9
Drawing office structure

1.5.1 Method of work initiation in a design office

No work should commence without a work request carrying the requisite information and signatures in a drawing office. The following information should be completed before commencement of work:

- Name of the person requesting the work.
- Name and signature of engineer authorizing work.
- Respective cost code.
- Date completed for 'work required by' field.
- Title of plant or work area.
- Comprehensive work description or title.
- Indicate on the work request information supplied, drawings required.
- Comments or reference
- Date received by drawing office
- Chief Draughtsman signature.
- Draughtsman's name to whom work is allocated.

1.6 Printing, distribution and control of copies

1.6.1 Sources of work for a design office

Figure 1.10 shows the main sources of work flowing into a typical drawing office. The drawing office provides a service to each of these sources of supply, and the work involved can be classified as below:

- Engineering department: the work would involve development, research, manufacturing techniques, project planning and testing.
- Sales department would require work in connection with general arrangement and outline drawings for tenders; illustrations, chart and graphs; feasibility studies; application and installation diagrams;

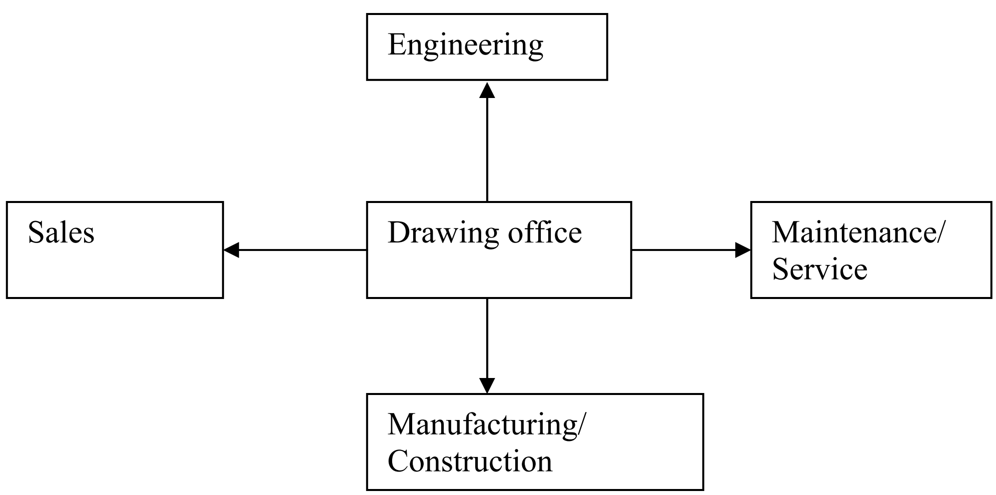


Figure 1.10
Sources of work in a drawing office

- Maintenance and service departments would require work in connection with maintenance tools, service manuals, modification in original design.
- Manufacturing units/project units would require work in connection with component assembly drawings; drawings of tools, jigs and fixtures; plant layout and project execution drawings.

1.6.2 Drawing distribution procedures

A formalized system of drawing approvals must be implemented in any drawing office to define the stage/status of a drawing- the following gives some suggestions as to how this process can be accommodated. A brief description for the drawings issued for various purposes is given below.

1.6.3 Drawings issued for approval

The approval drawing is a scheme, which requires approval from the engineer. These drawings are not to be issued for tender, construction or any consultant or contractor to use as final drawings. After approval of a drawing with all appropriate signatures the drawing need not be issued for reaprroval unless specifically requested on the approval form.

- Approval drawings are for internal use only i.e. client/design department.
- No construction may be carried out using approval drawing.
- Where approval of any drawing is required, it must be issued to the responsible engineer or Manager.
- If a second or third approval is required the drawing must state this.
- Drawing numbers refer to a single drawing or document. Two or more drawings cannot have the same number.
- A duplicate drawing can be issued and stamped accordingly.
- Wherever approval has been sought, the final drawing must state this.
- An approval drawing which has been approved need not be resubmitted.

1.6.4 Drawings issued for final approval

On completion of final drawings and prior to issue, a print shall be made and this shall be handed over to the Project Engineer for his signature and to record that final drawings have been issued to his approval, all previous comments having been acted on to his satisfaction. This shall not be used for further modifications.

1.6.5 Drawings issued for information only

There are a number of situations where a drawing may be issued for information only, i.e. these drawings may be worked to for manufacture or construction.

Drawing may be issued to a contractor for planning his construction program

- Drawings may be issued to a contractor for planning his construction program.
- Drawings may be issued to a supplier to assist in determining type of merchandise best suited to our requirements.
- Drawings may be issued to a Quantity Surveyor for preparation of Bill of Quantities.

1.6.6 Issued for tender

- Drawings shall be as complete as possible before issuing for tender purposes. The more information given at this stage the more accurate the quote and less likely future claim for extras.
- Where possible detail drawings should be sent at tender stage.
- Whenever possible drawings should be checked before going out on tender.
- Tender documents should carry a reference to all drawings, specifications, etc. which form a part of the tender.

1.6.7 Issued for manufacture or construction

- Any variation between drawings at tender stage and construction issue should be highlighted by way of a revision on the drawing.
- When issuing the drawing for construction to the fabricator, issues should also be made to client and a Quality Surveyor also should be involved.

1.6.8 As built

- Represents the final revision to all drawings reflecting actual changes made during the construction and commissioning of the plant.
- Usually forms part of the plant operating and maintenance documentation and must be archived on completion of the project.

1.6.9 Dimensional accuracy

This is of crucial importance. Dimensions must be checked on a local and overall basis. The orientation of each element must be checked in relation to the total unit. In this respect, an orientation diagram must be included on the drawing showing the relevant position of the item in question.

1.6.10 Checking procedures

- Checking procedures fall directly under the control of the Chief Draughtsman.
- The checking activity is the last line of defense in the system to ensure that a drawing represents as closely as possible the functional requirements of the job. As such the checker needs to critically analyze and question any proposals put forward.
- The checker has the right and may challenge, without prejudice any ideas, concepts or formulations that have been committed to paper.
- The checker shall not subscribe to any suggestion until the checker is totally convinced of its usefulness and fitness for purpose.
- No drawing shall be issued for manufacture unless it is authorized by a Checker.
- All drawings produced need to be checked before issue for tender.
- Except under special circumstances, drawings should be checked by an independent department.

A suggested color code for checking

- Red – Incorrect
- Yellow – Correct
- Green – To be used by draughtspersons when correcting errors. Green through red indicating that alteration has been done.
- Should there be revisions to a drawing once it has been signed off as checked then it should be returned for a further check.
- Wherever there is a point of contention between checker and the originating draughtsman, the Chief Draughtsman should be consulted.

1.6.11 Printing of drawings

Printing requirements normally fall into three categories:

- Printing for developing of working drawings
- Printing for issuing internally
- Printing for issuing externally

Procedure for printing, registering and filing:

- All prints should be officially requested.
- Where a job is deemed to be urgent then the Chief Draughtsman must prioritize.
- All other printing should be done on a 'First come first serve basis'.
- All drawings must be registered in the Master Drawing Register.
- Vendor drawings to be registered with relevant information separately.
- All completed drawings shall be filed in the appropriate place in the filing section – this may be a dedicated location on the server hard disk or a physical location for hard copies.
- A draughtsman should only have in his possession the drawing relevant to the job he is currently working on. All other drawings in his possession should be in the form of prints or microfilm prints and marked accordingly as copies.

1.6.12 Internal drawing release

Procedure for issuing and dispatching of drawings:

- All drawings issued through the Drawing Office/ Printing Section must be formally requested. All drawings issued should be accompanied by a document transmittal form which should be signed and returned and filed by the originator for record purpose.

Control of drawings:

- Controlled Copy of the drawing is released with necessary information mentioned in a format called 'Change Notice' and distributed to the concerned department.
- Change notice format contains all information like the number of changes, issue level, reason for change, further course of action(on the previous level component) and also indicates the distribution list.
- Change notice is issued along with a change notice return slip. The user of the drawing returns the change notice return slip to the originator indicating that the old level drawing has been destroyed.

1.6.13 Managing multiple copies

- Based on the change request from other department the drawing is updated and released with next change level to the concerned department.
- Old and new drawings are maintained in the respective files.
- Multiple copy drawings are issued only to certain departments like Purchase where there is a possibility to issue the drawings to various suppliers for different reasons.
- The change notice contains information about the number of copies distributed and it is then the responsibility of the concerned department to control these drawings.
- Additional copies are issued only on request and are properly controlled.

1.6.14 Use of CAD and management of CAD drawings

With the introduction of computer-aided drafting (commonly called CAD) there is a totally new dimension in the use and management of drawings. The ease of sharing, using a single drawing to represent different aspects of engineering and displaying them selectively and possibilities for on-screen reviews and in many cases distribution of drawings on-line have changed the way of generating, managing and distributing drawings. We will review these under a separate chapter in greater detail later. Some of the salient features of CAD drawing management are as follows:

- Drawings are controlled in a central area of the CAD system called as Archive.
- Drawings in the archive can be viewed by user having access to the CAD system.
- Drawings while under creation should be kept in the private area and should be placed in the central archive only after proper approvals.
- Drawings can be removed from the archive for changes as per the process and can be placed back in the archive with the next level of change.

1.7 Summary

Engineers and technical personnel associated with an engineering organization use drawings to convey graphically the ideas and plan necessary for execution and completion of a project involving construction or assembly of components or systems.

Drawings work as a tool for problem solving at various stages of working in an organization. The drawings are at the centre of activities taking place in an engineering organization whether a manufacturing organization or a turnkey contracting organization.

The different parts of the world started forming their own electro-technical societies in the nineteenth century as the need aroused for development of standards for the engineering processes. Two of the oldest electro-technical institutions that came into being were the American Institute of Electrical Engineers (IEEE) and the International Electro-technical Commission. These institutions have developed electro-technical standards which have benefited both the manufacturers and the users immensely. Some of the other important societies/standards related to the field of electrical engineering are NEC, NEMA and VDE.

Technical drawings are used to convey a large amount of exact, detailed information in an abbreviated language. They consist of lines, symbols, dimensions, and notations to accurately convey an engineer's designs to electricians/technicians who install the electrical system on a job. Some of the types of electrical drawings used for any project can be categorized as block diagrams, layout drawings, single line diagrams, wiring diagrams etc. All drawings should be prepared in line with the international standards mentioned above or any company specific standards.

The drawing office is a subset of the design and as such the overall authority resides with the Resident Engineer and the Project manager. Their requirements and decisions are passed on to the drawing office staff via the Chief Draughtsman. The function of the Chief Draughtsman is to take overall control of the services provided by the office. The Chief Draughtsman receives all the work coming into the drawing office which he examines and distributes to the appropriate section leaders. The section leader is responsible for a team of draughtsmen of different grades. When work is completed, the section leader then passes the drawings to the checking section. After the checking drawings are printed and released as per the prevalent standards of the company.