

# ●●● POWER ENGINEERING

## Fourth Class

Edition 3.5

### Fundamental Industrial Communication Skills

Part A

Unit A-10



**PanGlobal**

Partner in Education

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March 2026

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# **FUNDAMENTAL INDUSTRIAL COMMUNICATION SKILLS**

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## UNIT INTRODUCTION

Any language or form of communication requires rules that are understood by both the initiator and the audience. Standard rules also apply when creating and interpreting plant drawings. These rules are usually presented with the use of symbols, which have an agreed upon meaning. Some symbols are universally agreed upon, and some are exclusively used in one type of drawing. As well, plants themselves may have a unique set of communication tools.

Today, formal plant diagrams are almost exclusively drawn by using CAD software. This software can range from a simple 2-dimensional (2D) drawing tool, through to a fully integrated 3D modelling suite. Regardless of complexity, the software uses a library of standard symbols and blocks to ensure accurate diagram interpretation throughout the plant. Operators may create informal versions of plant diagrams either with CAD software, or make hand drawn sketches by using simple drawing tools.

Whether hand drawn or computer generated, PFDs, P&IDs, and other plant drawings are used throughout the lifecycle of a plant. From designers and construction personnel to operations and maintenance professionals, these drawings are valuable communication tools that help every team member understand what the plant does and how it does it.

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## UNIT RATIONALE

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By the end of this unit, the learner will grasp the basic principles of how to sketch and interpret plant drawings. Operators will need to create their own drawings from standard diagrams, and then validate them visually within the plant. These are valuable reference tools and improve understanding of how a plant works.





## Energy Plant Sketching

### LEARNING OUTCOME

*When you complete this chapter you should be able to:*

*Create engineering equipment sketches.*

### LEARNING OBJECTIVES

*Here is what you should be able to do when you complete each objective:*

1. *Create sketches using centre lines and dimensioning.*
2. *Recognize standard views of an object.*
3. *Recognize cross-hatching methods in sectional drawings.*
4. *Identify common symbols and lines used in plant system trace drawings.*
5. *Complete a plant line tracing.*





## CHAPTER INTRODUCTION

A technical sketch can be drawn freehand or with the use of simple drawing instruments. Its purpose may be to describe a machine part to the person responsible for making that part, or to illustrate an idea without making a formal drawing. In either case, it represents the sketch creator's vision and understanding of a piece of equipment.

Freehand sketching quickly translates the image to paper. Power Engineers often communicate via rough freehand sketches because they are informal, quick and easy to change, and less restrictive.

Whatever its particular purpose at the time, a sketch is always a valuable aid for effective communication between energy plant personnel. To be able to sketch clearly by using standard symbols is one of the most useful abilities a Power Engineer can possess.

## OBJECTIVE 1

*Create sketches using centre lines and dimensioning.*

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### CENTRE LINES

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During the operation of a plant, a special repair part may be required which must be made to certain specifications. With a sketch, all the necessary information, such as the shape and size, required to make the part can be conveyed in a few lines. Without a sketch, it may be more difficult to explain the desired result, either verbally or in writing. This will create a greater possibility of error.

Some hints on sketching freehand are included in this chapter. However, it may be just as quick to use a few simple drawing instruments which do a much better job. These inexpensive instruments are all that are required:

- Two triangles (60° and 45°)
- Scale or ruler
- Compasses
- Pencil
- Eraser

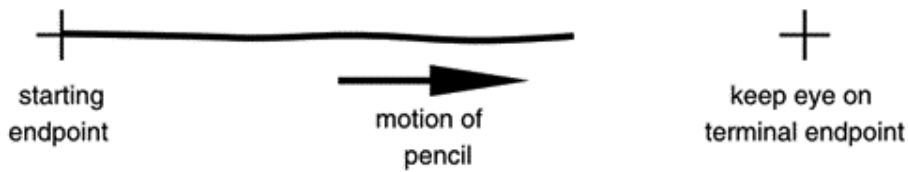
The proper way to make a sketch can be summed up in the following simple instructions:

1. Make sketches large. It is easier to draw on a large scale, and it shows details more clearly.
2. Begin with the centre lines and take all necessary measurements from them.
3. Make the sketch in proper proportion so that it looks like the object it is supposed to represent.
4. Lines needed only for construction purposes, such as centre lines, should be drawn lightly, but heavier lines should be used to outline the object being drawn.
5. Print the name of the component beneath the sketch, and put the names of the principal parts on the sketch.
  - a) Do not complicate a sketch with unnecessary detail.
  - b) Show only what is asked for, but show that on a large scale.

All sketches are made up of arcs and lines, so it is necessary to be able to draw circles and straight lines.

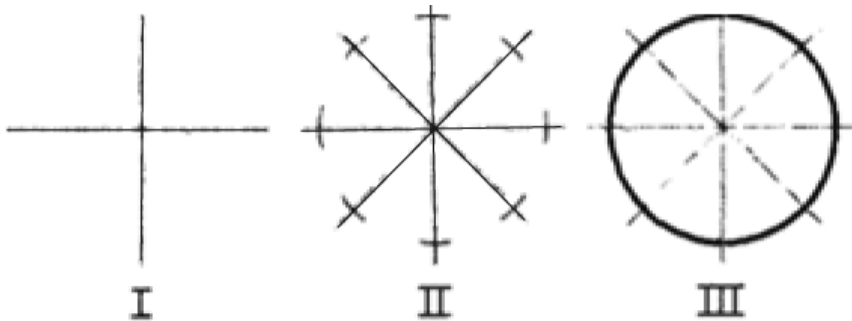
To sketch a straight line:

1. Sketch the endpoints of the line as dots or small crosses.
2. Place the pencil on the starting endpoint.
3. Keep an eye on the terminal endpoint, and use a smooth continuous stroke to draw the line between the endpoints.

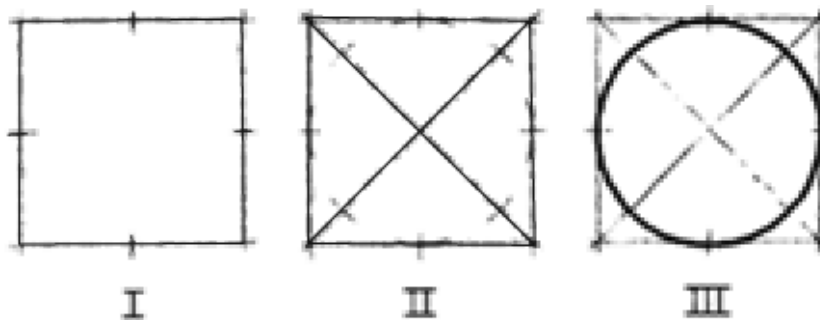

**Figure 1 – Drawing Lines**


To sketch a circle or arc:

1. Draw light horizontal and vertical lines that cross at the centre of the circle.
2. Lightly mark the radius of the circle on each line.
3. Connect the radius marks with a curved line to form a circle or arc, as necessary.

**Figure 2 – Drawing a Circle**


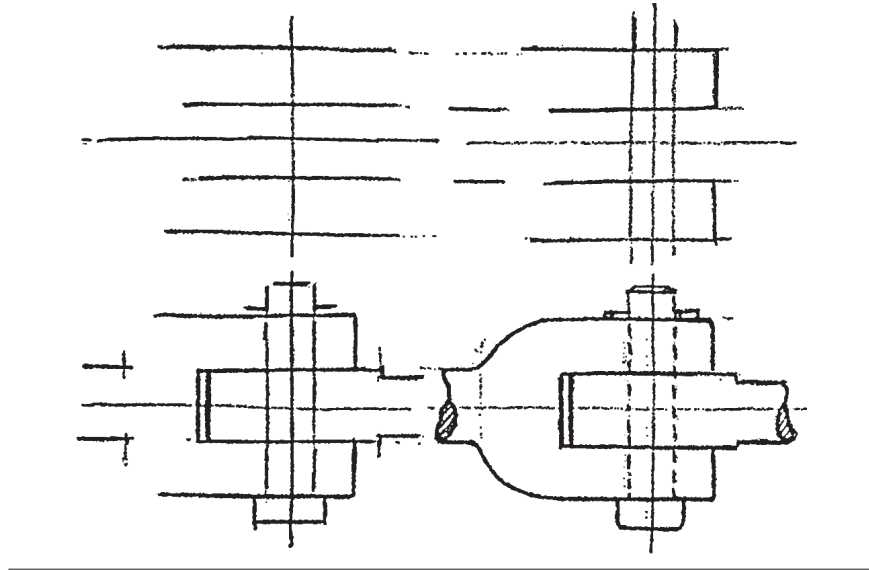
4. Alternatively, a lightly sketched square can be used as an enclosure. First, mark the mid-points on the sides. Then draw light arcs tangent to the sides of the square. Finally darken in the circle.

**Figure 3 – Drawing a Circle**


**Note:** It is generally easier to sketch a curve (circle, arc, etc.) on the concave side of the arc as the hand naturally pivots in this way.

A more complex sketch by drawing the foundation or centre lines is illustrated in Figure 4. This is a sketch of a knuckle joint. It has three preliminary steps or stages which illustrate how to easily make a freehand sketch of the right size and proportions.

**Figure 4 – Sketching a Knuckle Joint**



To make the sketch in Figure 4:

1. Draw the horizontal centre line. Then draw four horizontal parallel lines. Space the lines so that the inner part of the joint is somewhat wider than the outer sections of the forked member. Next, draw a vertical centre line for the pin. The sketch should now look like the one in the upper left hand corner of Figure 4. Draw the horizontal centre line and then four horizontal parallel lines spaced so that the inner part of the joint is somewhat wider than the outer sections of the forked member. Next, draw a vertical centre line for the pin. The sketch is now as represented in the upper left hand corner of the illustration.
2. For the second stage, shown in the upper right image, draw the lines spaced to suit the pin diameter. Except at the top, these lines represent a part of the pin that is concealed. They may be drawn in lightly, and dotted in afterwards. Draw vertical lines to locate the end of the fork.
3. In the third stage, shown in the lower left of the image, add the straight lines as shown to complete the basic shape.
4. In stage four, shown in the bottom right of the image, fill in the hidden features. Use dashed lines for the pin, and arcs for any curved elements. To give a 3D dimensional view, use a cross-hatch to indicate the shaft.

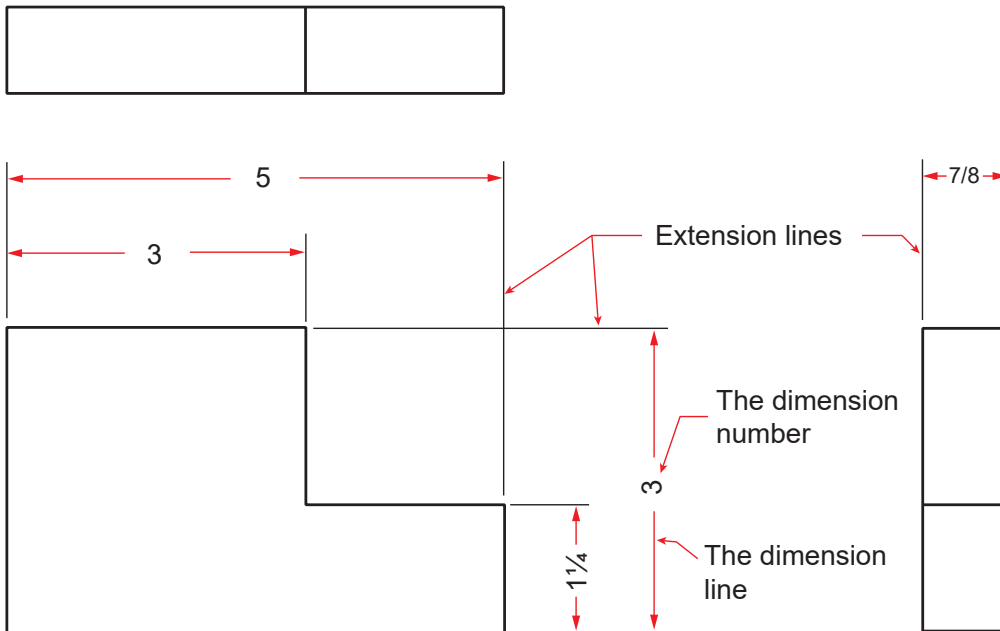
The result is a proportional sketch. All the prominent parts are clearly drawn, and it is ready for dimensioning.



## DIMENSIONING

So far, the sketch from Figure 4 only shows a shape. To be a useful working tool, it must be given size. Figure 5 shows an example of dimensioning on a simple sketch. The points at which the measurements are to be taken are brought out as “extension lines”. The dimension line then extends the full distance between these extension lines, with a break for the dimension number.

**Figure 5 – Typical Dimensions on a Working Drawing**



For all sketching, always draw the most important lines first. They are the ones that establish the main proportions of the sketch and enable proportioning to be done. The practical application of this principle of sketching will be illustrated by the different examples that follow.

## OBJECTIVE 2

Recognize standard views of an object.

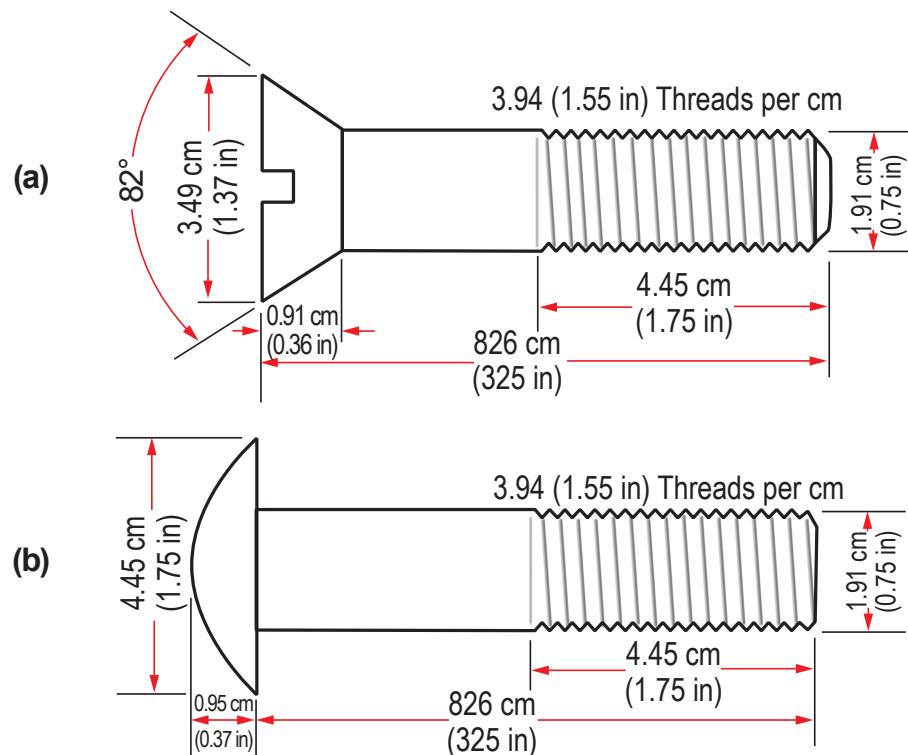
### STANDARD OBJECT VIEWS

#### Sketches Requiring Only One View

The sketch in Figure 6(a) shows an American Standard flat-head cap screw. Figure 6(b) is an American Standard button head machine bolt. The dimensions are provided in SI units.

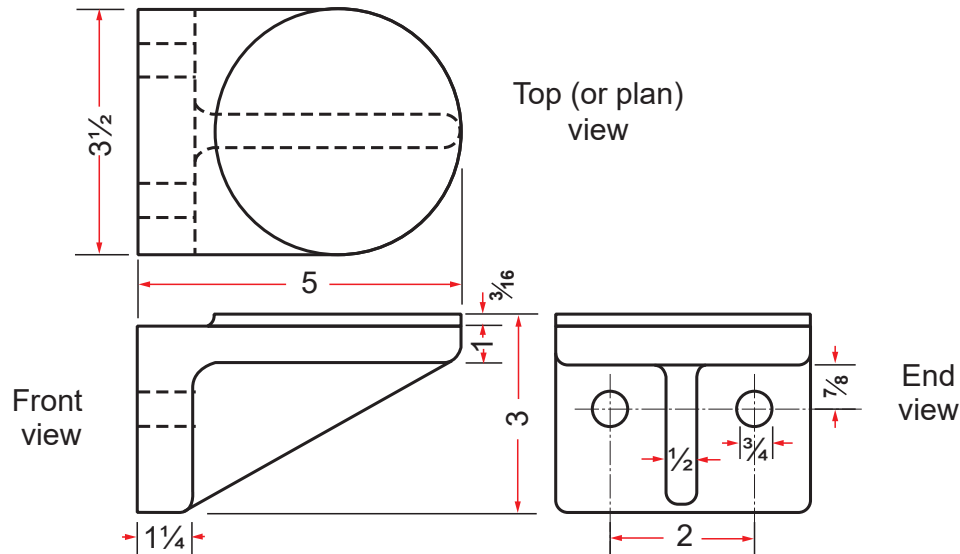
One view of such simple parts is sufficient. An end view to show that the head is round is unnecessary.

Figure 6 – Examples of Sketches Requiring One View Only



#### Sketches Requiring Two or More Views

The bracket shown in Figure 7 requires three views to represent its shape. The top (or plan) view shows the circular form of the pad (or raised part) on the top of the bracket. The end view, at the right, shows the shape of the back plate, the width and shape of the central stiffening rib, and the exact locations of the bolt-holes. The front view shows the slope of the stiffening rib and the thickness of the raised pad. If any of the three views is missing, the sketch becomes incomplete; there will be insufficient information to construct the bracket as required.


**Figure 7 – Sketch of a Bracket Requiring Three Views to Show Its Form**


## Standard Views

Figure 8 illustrates the standard views used in engineering drawing practice. Six views are shown, but there are rarely more than three used. The three most commonly used include:

- Front Elevation
- Plan (or top view)
- One Side Elevation

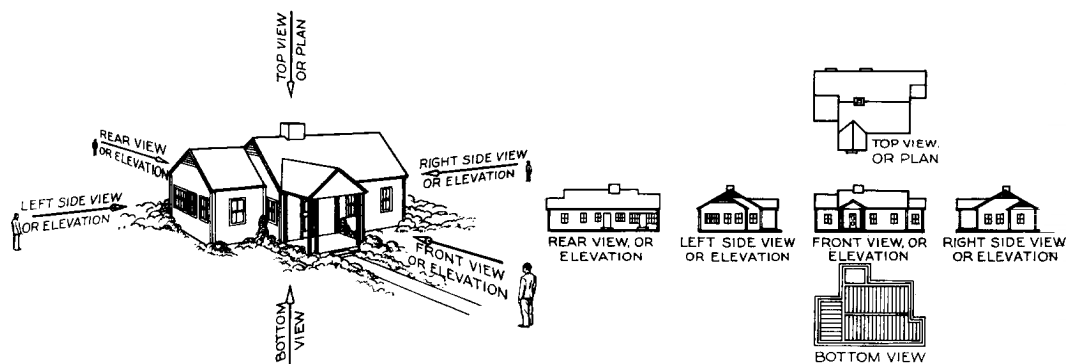
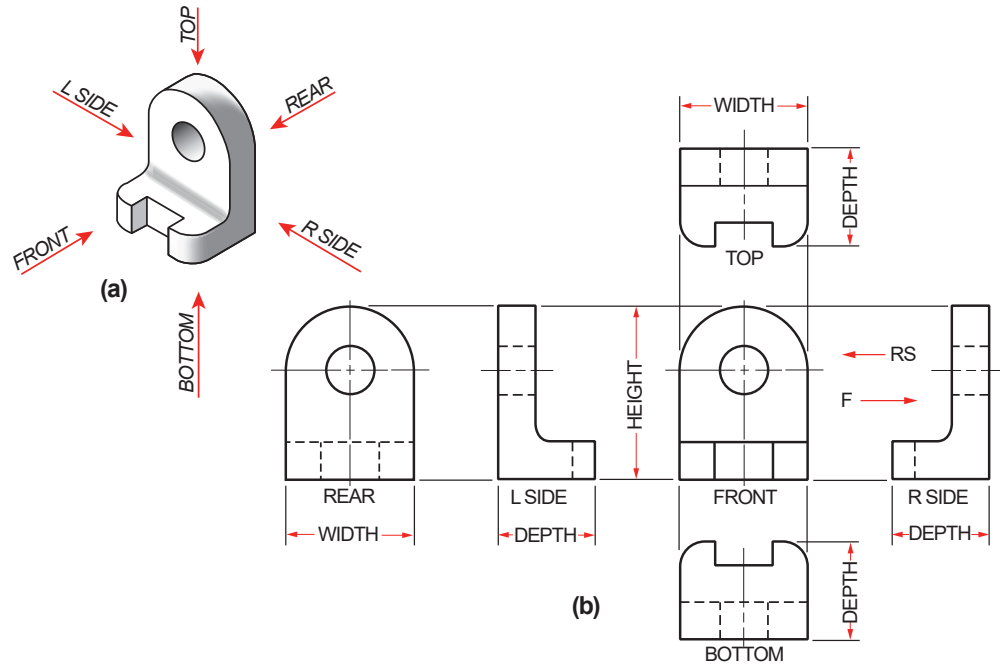
**Figure 8 – Six Views of a House**


Figure 9 gives further illustration of the six standard views. Note that the front elevation is usually used as the key view. The remaining views are projected from this one.

**Figure 9 – Six Views**



In each case, the name of the view shows the object as it appears when viewed from the stated direction. For example, the right side view shows the appearance of the object when viewed from the right side, and so on.



## OBJECTIVE 3

*Recognize cross-hatching methods in sectional drawings.*

## SECTIONING

In order to show all the necessary details on a sketch, the object is often shown in section, or as it would appear if cut in half, through the centre line. When this is done, all the parts that are cut through are cross-hatched or section lined. Different materials of construction can be indicated by the design of cross-hatching that is used.

Figure 10 illustrates how to section line parts that are adjacent to each other. Section lines should generally be drawn at a 45° angle. Two adjacent parts should be sectioned in opposite directions. A third part, adjacent to both, is sectioned at a 30° or 60° angle.

**Figure 10 – Section Lining**

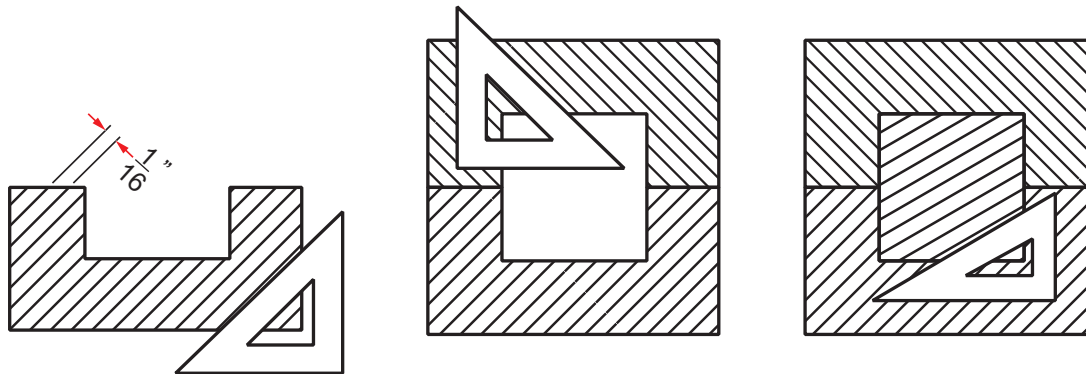




Figure 11 shows the American Standard sectioning symbols used to indicate various materials.

**Figure 11 – American Standard Symbols**

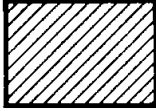
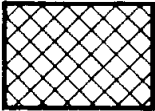
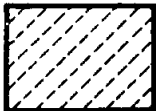
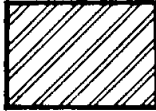

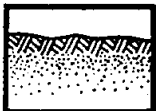
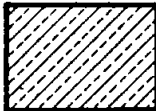


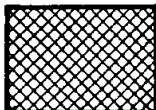
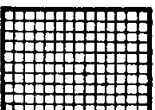
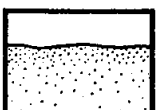
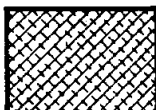
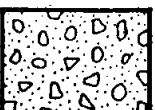




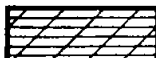
	Cast Iron		Solid or heat insulation. Cork, hair-felt, wool, asbestos, magnesia, packing, etc.		Marble, slate, glass, porcelain, etc.
	Steel		Flexible material. Fabric, felt, rubber, etc.		Earth
	Bronze, brass, copper & compositions		Fire brick & refractory material		Rock
	White metal, zinc, lead, babbitt & alloys		Electric windings, electromagnets resistance, etc.		Sand
	Aluminum & aluminum alloys		Concrete		Water & other liquids
	Electric insulation, Vulcanite, fibre, mica, Bakelite, etc.		Brick or stone masonry		Wood
	Show solid for narrow sections				



Figure 12 shows a sectioned sketch of a gate valve. Note that the internal details of the valve are illustrated by correct sectioning. The cross-hatching used indicates that the material is cast iron.

**Figure 12 – Section Lining in a Valve**

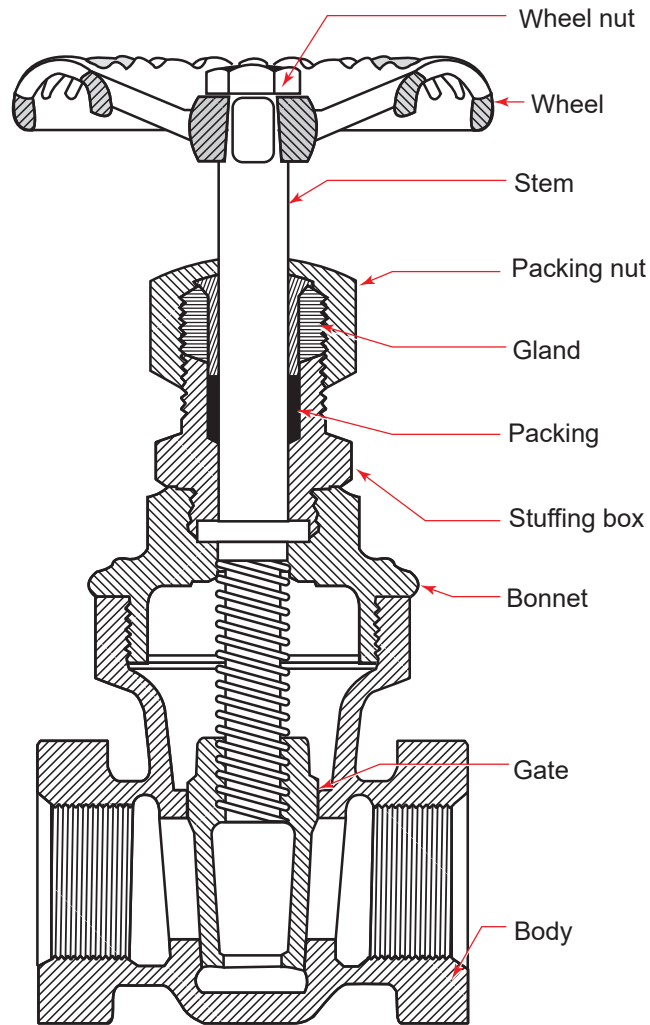
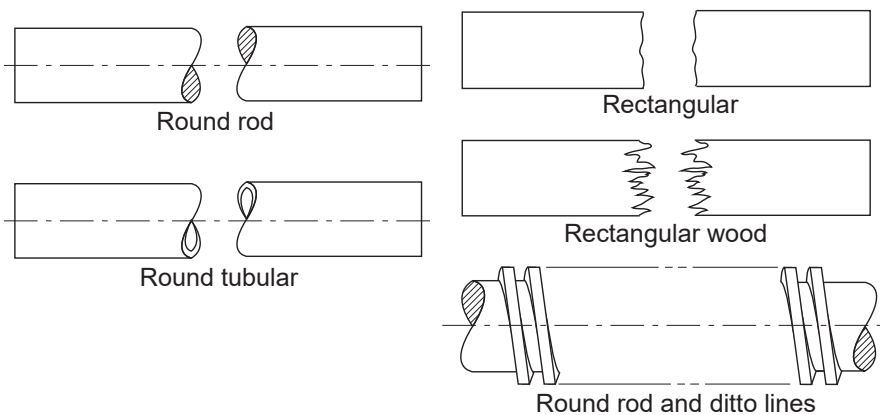


Figure 13 shows the conventional method of indicating breaks in a long rod, tube, or shaft. This break is usually done when it is inconvenient to draw a whole length, or to indicate the shape to be used.

**Figure 13 – Indicating Breaks**



## OBJECTIVE 4

Identify common symbols and lines used in plant system trace drawings.

### EQUIPMENT SYMBOLS

Plant operators need to become familiar with how to sketch and draw individual pieces of equipment. Sometimes, it will be important to place different pieces of equipment on the same drawing. This provides a system view of the equipment in relation to other components in the plant. Figure 14 shows a generic set of symbols that can be used to trace and draw plant systems. The figure includes examples of:

- Major and minor pieces of equipment found in operating plants
- Ancillary equipment
- Instrument symbols

Figure 14 – Equipment Symbols

#### Valves

	Hand-operated gate valve		Butterfly valve		Solenoid valve
	Gate valve		Control valve		Motor-operated valve
	Closed gate valve		Back pressure regulator		Relief valve
	Hand-operated globe valve		Plug or cock valve		Needle valve
	Globe valve		Check valve		3-way valve
	Angle blowdown valve		Powered valve		

#### Compressors

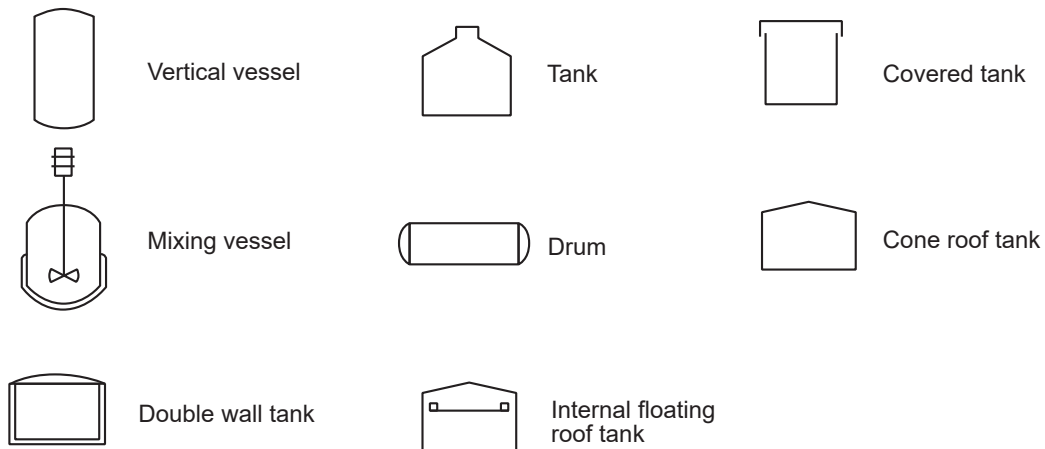
	Compressor		Liquid ring compressor		Axial compressor
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#### Pumps

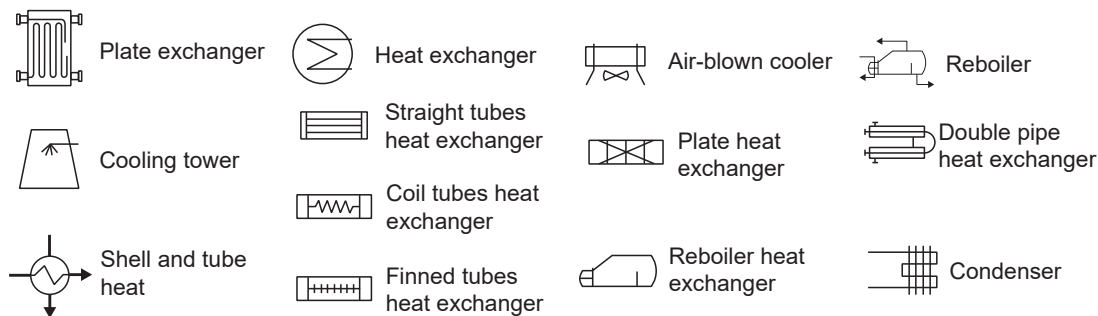
	Generic		Centrifugal pump		Turbine driver		Reciprocating pump
	Reciprocating pump		Rotary pump		Doubleflow turbine		Fan



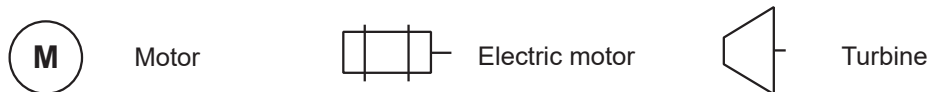
### Vessels



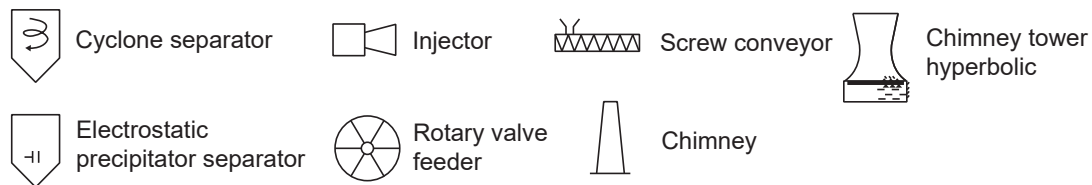
### Heat Exchangers



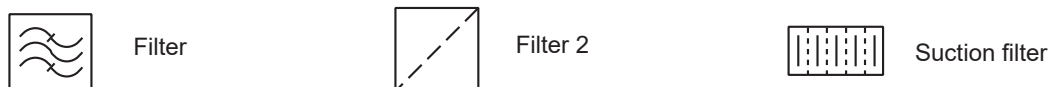
### Motors



### Miscellaneous



### Filters



















## LINE STYLES

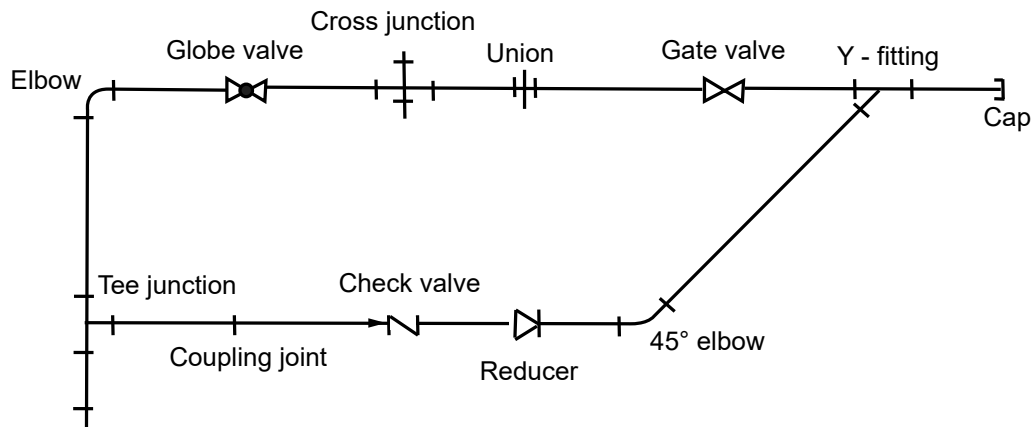
In complex piping systems, such as those in an energy facility, a simple sketch identifying the components may not always provide enough information to answer the question asked about the system. In this case, the operator will need to provide piping and connection details as well. Figure 15 provides an overview of examples of symbols used to provide connecting information, both in piping and networking connectivity.

**Figure 15 – Common Piping and Connection Symbols**

	Major pipeline		End cap
	Connect pipeline		Steam trap
	Crossing pipes - not connected		Ejector or eductor
	Crossing pipes - connected		Union
	Y-type strainer		Reducer
	Rotary valve		Pulsation dampener
	Orifice plate		Duplex strainer

A single line drawing is the most commonly used format in standard plant drawings. Figure 16 is an example of a single line drawing that uses equipment, piping, and connection symbols.

**Figure 16 – Example One Line Drawing**





Piping connections are not the only ones identified on plant diagrams. Measurement and control signals are carried through various transmission lines. In most cases, the control elements are overlaid on top of a solid connection line. A thin solid line represents process connections to instruments. The following are common combinations:

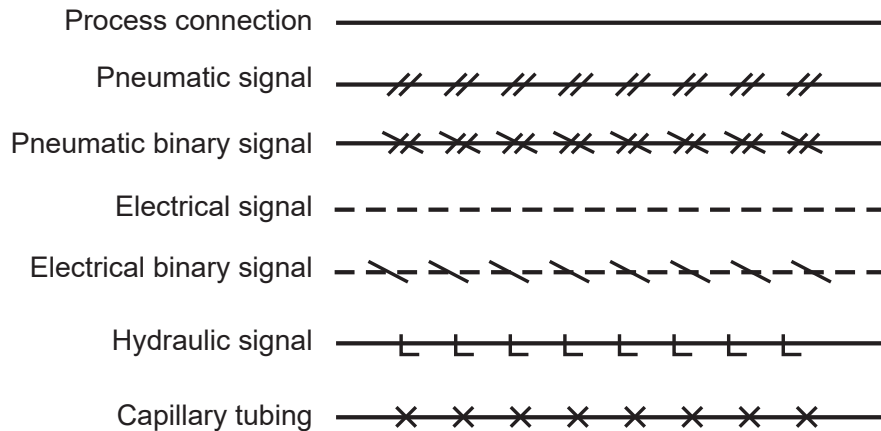
- A dashed line represents electrical signals (e.g., 4–20 mA connections).
- A solid line with double backslash marks represents pneumatic signal tubing.
- A dashed line with forward slash marks on it represents data links.

Other connection symbols include:

- Capillary tubing for filled systems (e.g., remote diaphragm seals)
- Hydraulic signal lines
- Guided or unguided electromagnetic or sonic signals. Electric or electromagnetic signals are instantaneous.

Various process piping, connection, and transmission lines are listed in Figure 17, as per the standard set by the **International Society of Automation (ISA)**.

**Figure 17 – Measurement and Control Lines**



## OBJECTIVE 5

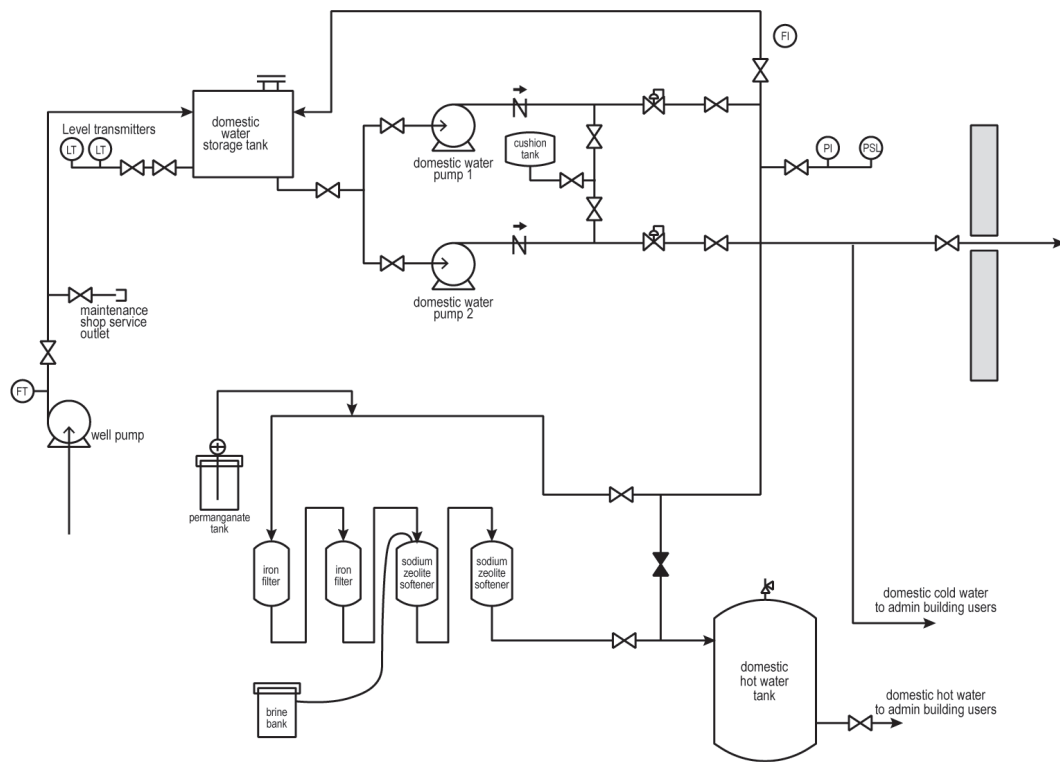
Complete a plant line tracing.

### PLANT LINE TRACING

It has been a long-standing practice for Power Engineers in training to trace the plant processes by constructing a single line sketch at the site where they work. Usually, a typical formal line diagram of a plant or system is very complicated. The novice may find it difficult to understand. It is a good idea to keep these diagrams for reference, and trace them physically.

Single line sketches are simple to construct. Free hand sketches are often acceptable. Power Engineers often use note books or sketch pads that are easy to carry, and draw rough drafts of the sketches in pencil for easy revision. Figure 18 is an example of a drawing made by a Power Engineer in training.

Figure 18 – Single Line Sketch of Water Treatment System from Engineer in Training





The sketch is a fair representation of the water treatment system. However, a number of features need to be pointed out:

- This is a rough sketch and does not include all the features of the system, just those pertinent to the discussion.
- The sketch contains both hand drawn and computer drafted elements
- The sketch layout does not accurately represent the spatial connections between different equipment as it tries to minimize lines from crossing.
- Pipe sizing is not shown.
- Not all process flows are indicated.
- Not all valves are shown.
- Only a generic symbol for valve is used.
- A plant specific symbol for pump is used.

Final copies of sketches are often coloured to add additional value for later reference. These colours are applied for varying reasons including:

- To clearly identify all the different pieces of equipment clearly.
- To set apart the different processes (arbitrary colours).
- Piping lines connecting the equipment may also be coloured to indicate fluid type and flow.

Different plants will identify their piping colours in different ways. Some universal colour indications to identify fluids are generally recommended in registered plants. The following recommendations reflect those outlined in the **ASME A13.1 Pipe Marking Standard**. In this standard, labels are placed:

- Adjacent to all valves and flanges.
- Adjacent to all changes in pipe direction.
- On both sides of wall, floor, or ceiling penetrations.
- Every 7.5 to 15 meters on straight runs of pipe.

Table 1 provides an overview of this pipe-labelling standard.

Table 1 – ASME A13.1 Piping Labelling Overview		
Material Properties	Letter Colour on Field Colour	Example
<b>Flammable:</b> fluids that are a vapour or produce vapours which can ignite and continue to burn in air	<b>Black on Yellow</b>	→ Ammonia →
<b>Combustible:</b> fluids that may burn but are not flammable	<b>White on Brown</b>	→ Diesel Fuel →
<b>Toxic and Corrosive:</b> fluids that are corrosive or toxic produce corrosive or toxic substances	<b>Black on Orange</b>	→ Sulfuric Acid →
<b>Fire quenching:</b> water and other substances used in sprinkler firefighting piping systems	<b>White on Red</b>	→ Fire Sprinkler →
<b>Other water:</b> any other water, except water used in sprinkler and firefighting piping systems	<b>White on Green</b>	→ Boiler Feed →
<b>Compressed air:</b> any vapour or gas under pressure that does not fit the category above	<b>White on Blue</b>	→ Compressed Air →

The following are some of the acceptable practices used in tracing.

- a) Standardized symbols, such as those provided in this chapter, are often used to simplify learning, and provide clarity of the process.
- b) Adding personal notes to help remark on specific operating conditions. For example:
  - i. “Manual main fuel valve is very sensitive to tripping. Open with care, slow and steady.”
  - ii. “High point vent valve on the top of the domestic hot water tank is located 10 m east of the sodium zeolite softeners, and 3 m from the ground. Scaffolding and fall arrest requirements applies.”
  - iii. “Note: Actual location and position of equipment are not included with PFDs and P&IDs.”
  - iv. “Pipe designated colour coding: plant specific or ASME.
    - The plant may have its own documented colour coding for different piping containing different fluids. For example, water (blue), steam (red), and gas (yellow).”
- c) Verify that the information is up-to-date. Record and report any discrepancies for updates and revisions.
- d) Compare the personal hand drawn sketch with the current formal diagrams to improve learning and understanding of the process.
- e) For many plant sites, one of the major parts of the competent qualification requirement for a trainee is to
  - i. Sketch a single line diagram on a white board from memory.
  - ii. Explain the process with the aid of the sketch.
  - iii. Answer questions from a selected group of evaluators; including senior operators, supervisors, and trainers.

Well-prepared and accurate personal hand drawn single line sketches are often compared to well written school notes. They are helpful for the successful training and development of learners. In this case, they are the Power Engineers training in a plant site.

---

---

## COMPLETE A TRACE DRAWING

---

Using Figure 19, create a line trace drawing of the fuel lines in the photo. The fuel lines are yellow. In every new plant or area of work, a new set of line trace drawings will need to be completed. Initially, review the formal plant diagrams. Then physically trace the lines in the field (plant).



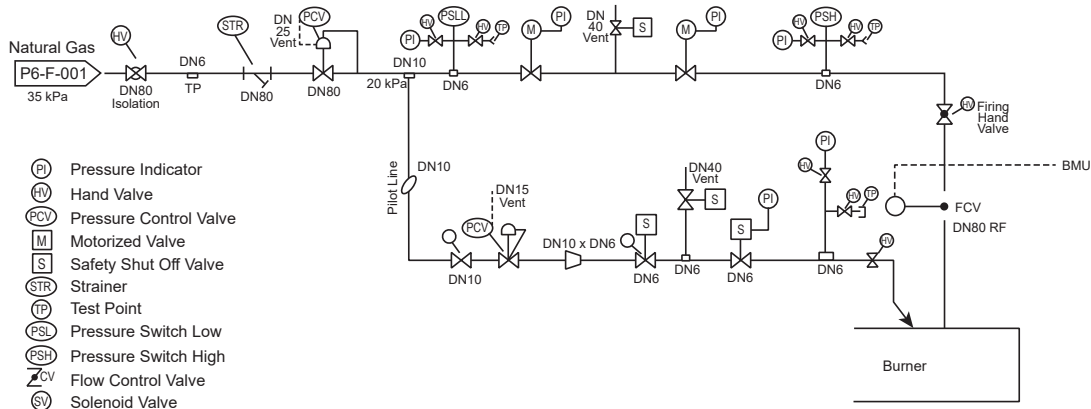
**Figure 19 – Boiler Gas Train**



(Courtesy of GPRC Power Lab)

On the formal diagrams of a different gas train (Figure 20), the lines, valves, and instrumentation are all in a nice line. In the field, they may be all over. Tracing is necessary to know the physical location of all isolation valves, fittings, and instrumentation.

**Figure 20 – Gas Train P&ID**



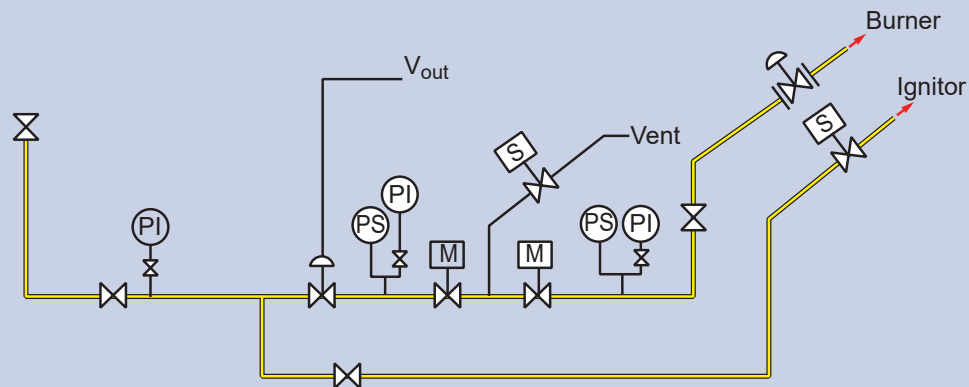
REFERENCE DIAGRAMS	GENERAL NOTES	REVISIONS	EQUIP TAG #	 PanGlobal Training Systems	
			DRAWN BY B.S.		Date 15.12.09
			APPROVED		Date
		NO BY CKD DESCRIPTION Date		TITLE <b>P &amp; ID Fuel and Burner                      Water Tube Boiler</b>	
			SCALE N.T.S.	DWG# 300 - WT01 - 01	
				REV A	

To initiate the drawing from Figure 19, start at the left side of the photo.

- a) The first item to draw is the isolation valve on the vertical line.
- b) A drip leg, or dirt pocket is under the “T” going to the gas train.
- c) Another isolation valve followed by a pressure gauge (shown as “PI” for Pressure Indicator), then a “Y” strainer.
- d) A pressure-regulating valve is next, which also has a vent line that is vented outdoors.
- e) After the PRV is a low gas pressure switch and pressure indicator (the switch is hard to see in the photo, it is behind the gauge).
- f) Coming off the main line is the small tubular line for the igniter.
- g) Show the isolation valve, “Y” Strainer, then follow the stainless steel line up to the solenoid valve, before it enters the burner assembly.
- h) On the main line again, there are two power-actuated valves. There is a vent between them with a normally open (open when there is no power, closed when the powered valves are open) solenoid valve vented to the outside.
- i) Next is another pressure switch and pressure indicator (not visible in the photo).
- j) Closer to the burner is another isolation valve (a firing valve), and the control valve that modulates how much fuel is allowed to the burner.

### Self-Test 1

Make a formal P&ID of the sketch of the boiler gas train below.





## CHAPTER SUMMARY

Being able to communicate is critical to the operating environment of an energy plant. Often this communication is best handled by a visual representation.

Power Engineers are regularly required to make sketches of plant equipment and components, both individually and within the system. This is an effective learning tool to understand how plants work. It is an additional tool that helps identify physical operating characteristics that may be improved upon.

Knowledge of how the system functions and the interrelationship of equipment is critical to effectively manage operating processes.





## Plant Diagrams and Drawings

### LEARNING OUTCOME

*When you complete this chapter you should be able to:  
Identify common types of diagrams used in plants.*

### LEARNING OBJECTIVES

*Here is what you should be able to do when you complete each objective:*

1. *Explain the layout of plant diagrams.*
2. *Explain the use of process flow diagrams (PFDs).*
3. *Explain the use of piping and instrumentation diagrams (P&IDs).*
4. *Explain the use of general arrangement, block plans, and equipment diagrams.*





## CHAPTER INTRODUCTION

The ability to read and understand information contained on plant diagrams is essential to perform most Power Engineering related jobs. Engineering diagrams are the industry's means of communicating detailed and accurate information on how to fabricate, assemble, troubleshoot, repair, and operate a piece of equipment or a system.

To understand how to “read” a diagram, it is necessary to be familiar with the standard conventions, rules, and basic symbols used on the various types of diagrams. But before learning how to read the actual “diagram,” an understanding of the information contained in the various non-diagram areas of a print is also necessary.

## OBJECTIVE 1

*Explain the layout of plant diagrams.*

---

### PLANT DIAGRAM LAYOUT

---

There are many different diagrams available for plant operators:

- **Process Flow Diagram (PFD)**
- **Pipe & Instrument Diagram (P&ID)**
- General Arrangement (GA) Diagram
- Block Diagram
- Electrical Single Line Diagrams and Schematics
- Equipment Diagrams

Each of these diagrams has a specific purpose, with custom features, and symbols in its use. Before discussing the individual types, it is useful to identify the features that are common to all standard plant diagrams.

Standard Plant diagrams can be divided into five major areas or parts.

1. **Title Block**
2. Grid System
3. **Revision Block**
4. Notes and Legends
5. Engineering Diagram (graphic portion)

The information contained in the diagrams themselves will be covered in subsequent objectives. This objective will cover the non-diagram portions of a print.

The first four parts listed above provide important information about the actual diagram. The ability to understand the information contained in these areas is as important as being able to read the diagram itself. Failure to understand these areas can result in improper use or the misinterpretation of the diagram.

#### Title Block

The title block of a diagram, usually located on the bottom or lower right hand corner, contains all the information necessary to identify the diagram, and to verify its validity. Information most often included in the title block includes:

- a) The diagram title, diagram number, site location, and diagram owner.
- b) Signed and dated approval of the plan developers.
- c) A reference list of other diagrams that are related to the system or component. It can also list all the other diagrams that are cross-referenced, depending on the plant's conventions.
- d) Diagrams can be classified as either with or without scale.
  - i. Diagrams without a scale usually show only functional information about the component or system.
  - ii. Scale diagrams permit large objects to be depicted in a size small enough to fit on paper. Scale diagrams also permit the enlarged depiction of small parts, so details are easier to observe.




## Notes and Legend

Diagrams are comprised of symbols and lines that represent components or systems. Although a majority of the symbols and lines are standardized among all diagram types, a few unique symbols and conventions must be explained for each diagram. The notes and legends section of a diagram lists and explains any special symbols and conventions used on the diagram, as illustrated in Figure 2.



### Figure 2 – Example Notes and Legend Section

#### NOTES:

1. SEE DWG. W829617 FOR DISC.  
SWITCH DEVELOPMENT
2. SEE DWG. W82961 FOR SSS SW#1  
AND SSS SW#2 SWITCH DEVELOPMENT.
3. TO LIMIT THE MAXIMUM FIRING CURRENT THRU  
THE FIA-BIA RELAY CONTACTS, THE F2A-82A  
RELAY CONTACTS, THE SSS SW#1 CONTACTS,  
AND THE SSS SW#2 CONTACTS,  
THE LENGTH OF 124VDC CIRCUIT CONDUCTORS  
FROM THE EXPLOSIVE VALVE BYPASS PANEL  
TO EACH VALVE PRIMER SHALL BE 500 FT   
OF 2/C #18 SHIELDED RADIATION RESISTANT  
CABLE.

#### LEGEND:

SEE DWG. W827700 FOR ADDITIONAL SYMBOLS

-  SSS PANEL, FAR SIDE  
FSA
-  DISC. SWITCH COMPARTMENT, FAR SIDE A  
(IN SSS PANEL)  
FSA



## OBJECTIVE 2

*Explain the use of process flow diagrams (PFDs).*

---

### PROCESS FLOW DIAGRAM (PFD)

---

The process flow diagram (PFD) is a simplified schematic of a plant, or portion of a plant. It uses graphic symbols to show the major equipment items, and the major process flow between the equipment. The components of the PFDs are not drawn to scale, only the inter-relationships between the equipment in the process are shown, but not in exact orientation.

PFDs provide valuable information for plant operating and engineering staff. They help with general understanding of the process flows and control strategy. PFDs are good resources for the purpose of training new personnel.

#### Layout of the PFD

A separate PFD may be prepared for each plant process. If a single sheet is too crowded, more sheets may be used. For simple processes, more than one process may be shown on a sheet. Process lines should have the flow rate, direction of flow, and other required data, such as pressures and temperatures. Main process flows should go from the left to the right of the sheet. Line sizes are not shown on a PFD.

With PFDs, simplicity in presentation is important.

Typical details shown on PFDs include:

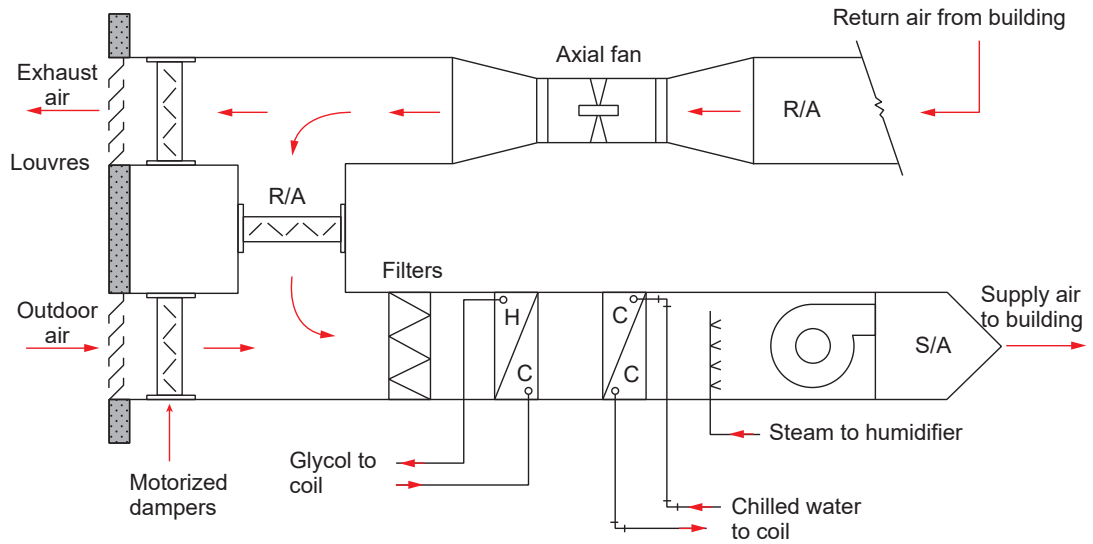
- a) Major process equipment with process line orientation, including proper name and numbering.
- b) Main piping, including major bypass and recirculation lines, and direction of flow.
- c) System ratings and operating values including flows and rates, pressure, and temperature values (often at the major vessels or control points).
- d) General configuration and process orientation of equipment.
- e) Major instrumentation, such as major control valve locations (excluding isolating and shut-off valves), and basic instrumentation orientation.
- f) Make up of fluids in the process.

## Process Flow Schematic Diagram Examples

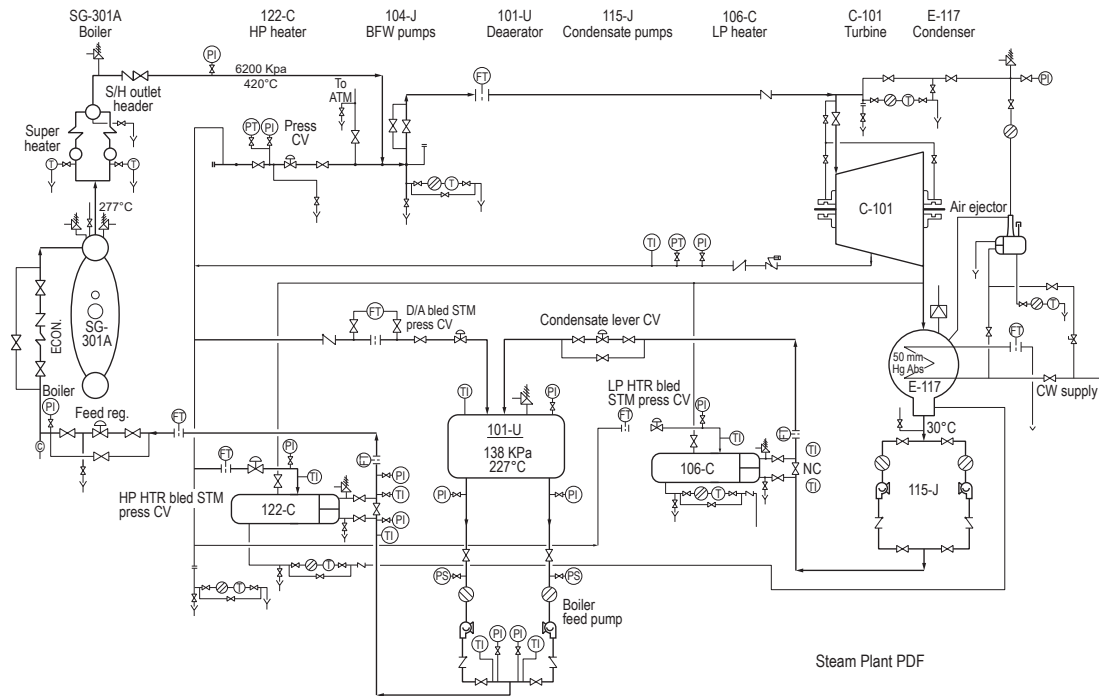
Typical process flow schematic diagrams are shown in Figure 3. Figure 3(a) shows the main process flows of a heating ventilation and air conditioning (HVAC) system.

**Figure 3 – Process Flow Schematic Diagram Examples**

**(a) HVAC Process Flow Schematic Diagram**



**(b) Steam System Process Flow Diagram**





## OBJECTIVE 3

*Explain the use of piping and instrumentation diagrams (P&IDs).*

### PIPING AND INSTRUMENTATION DIAGRAM (P&ID)

The P&ID includes more and different detail than the PFD. The P&ID expands upon the basic information from the PFD to show details of:

- Each major piece of equipment
- General piping orientation
- Basic control and instrumentation devices, and their orientation

The P&ID is not drawn to scale, although sizing is often included. The P&ID will not show the exact orientation of equipment, except for order of occurrence. These diagrams only present information on how a system functions, not the actual physical locations.

Because P&IDs provide the most concise format for how a system should function, they are used extensively in the operation, repair, and modification of the plant.

#### P&ID Details

The typical detail shown on a P&ID includes:

- a) Flow lines (including process piping) complete with line identification, and specifications which include:
  - Size
  - Insulation requirements
  - Valve sizes and types (including drains, vents, and fittings), and connections (threaded, flanged, or welded)
- b) Equipment details:
  - Vessel size
  - Insulation requirements
  - Power
  - External mechanical details
  - Controls
  - Instrumentation
  - Utilities
  - All connections
- c) Instrumentation identified for:
  - Monitoring
  - Indicating
  - Transmitting
  - Recording
  - Controlling devices for pressure, temperature, level, and flow rates
  - Safety
  - Relief
  - Shutdown
  - End devices

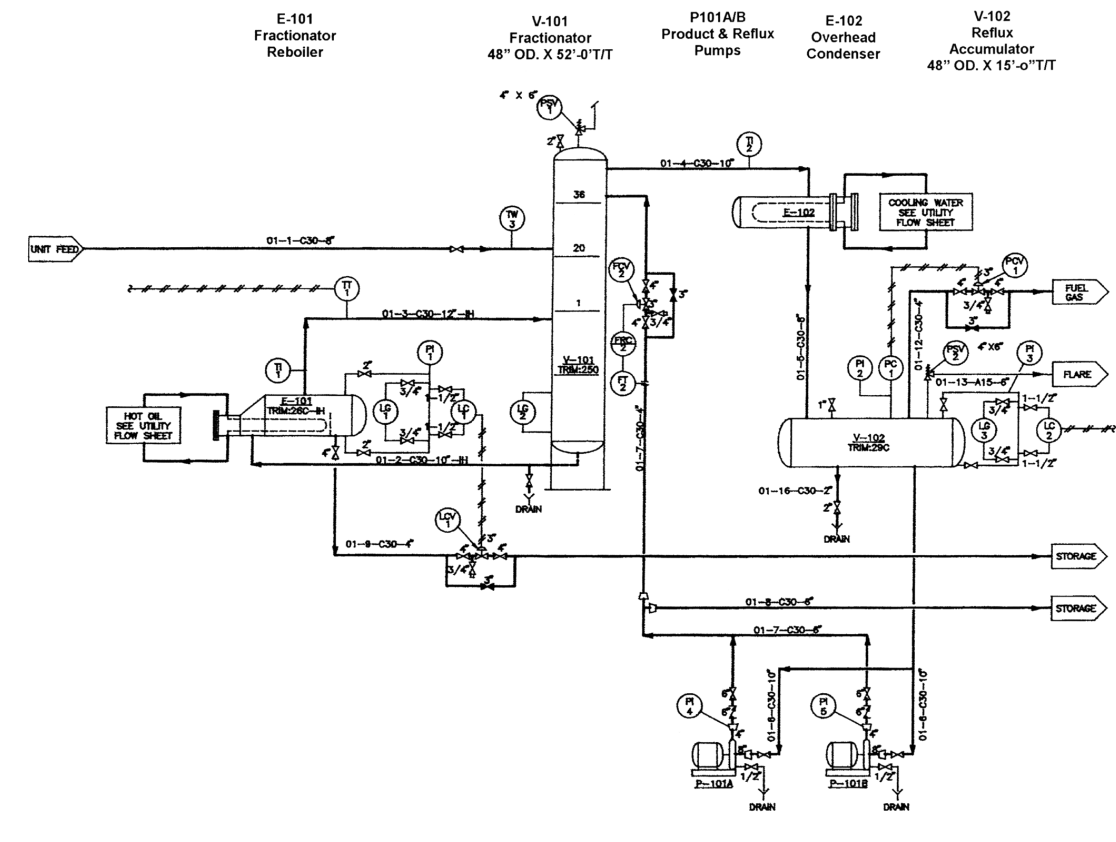
## Purpose of the P&ID

The P&ID is used for the following purposes:

- During the design and pre-construction phases, the engineering contractor will use the P&ID to develop detailed lists of parts equipment, instrumentation, and electrical devices from which cost estimates and bid proposals can be generated. The P&IDs graphically show the results of the mechanical design engineer's work. They include all that is incorporated in the completed construction project. The P&ID and the PFD are usually sufficient to define the scope of a project.
- During construction, P&IDs provide the field construction and inspection personnel with a reference to ensure that all equipment, instrumentation, piping, valves, and insulation, are properly located and interrelated.
- After construction, P&IDs are an invaluable operational and training reference for plant operating and engineering staff. They assist in understanding the details of the process, its instrumentation control system, the relationship between process, utility, and electrical systems. They provide an index to detailed piping, isometric diagrams, and equipment or instrument data sheets.

Figure 4 shows the main elements of a typical P&ID diagram.

**Figure 4 – Typical P&ID Without Title Block**








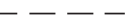











This diagram may look similar in makeup to the PFD shown in Figure 3, but it has much more detail. Although still not to scale, it supplies the type of information required to order or maintain component inventories. You may note some of the following features:

- Valve sizing
- References to other diagrams
- Piping identifiers

## Common P&ID Symbols

P&IDs come in sets for a particular plant or section of a larger plant. The set of diagrams includes a legend showing all the symbols. The previous chapter indicated standard diagram symbols. Figure 5 shows a sample of a list of standard symbols.

**Figure 5 – P&ID Symbols**

<b>Valve Symbols</b>		<b>Line Symbols</b>	
	Gate valve		Instrument air line
	Globe valve		Instrument electrical
	Check valve		Instrument capillary tubing
	Control valve		Pipe
	Plug valve	<b>P &amp; ID Abbreviations</b>	
	Ball valve		
	Butterfly valve		
<b>Miscellaneous symbols</b>			
	Spectacle blind open	CSO - Car seal open	
	Spectacle blind closed	CSC - Car seal closed	
	Orifice flanges	DF - Drain funnel	
	Piping specialty item	LC - Lock closed	
		LO - Lock open	
		NC - Normally closed	
		NO - Normally open	
		PO - Pump out	
		SC - Sample connection	
		SO - Steam out	

**Diagram Abbreviations** represent standard terms that are used on P&ID diagrams. Some examples are NO for normally open valves, NC for normally closed valves, and SO for steam out.

**Specialty Symbols** may be used for specific items that are not common on all P&ID diagrams. For example, spectacle blinds and specialty piping items.

Instrumentation data is also contained on P&IDs and is listed with the piping symbols. Figure 6 shows a list of P&ID instrumentation symbols. It includes symbols for flow, temperature, level, and pressure instruments. There are also symbols for miscellaneous items such as transmitters and hand control valves. Symbols for board mounted and locally mounted instruments are also shown. The board mounted (control room) instruments appear as circles with horizontal lines through them. The locally or field mounted instruments have no line.



Note that the first letter stands for the measurement type.

**F** for Flow

**P** for Pressure

**T** for Temperature

**L** for Level

The second letter is for the type of instrument.

**I** = Indicator

**R** = Recorder

**T** = Transmitter

**C** = Controller

**A** = Alarm

**RC** = Recording Controller

**LIC** = Level Indicating Controller

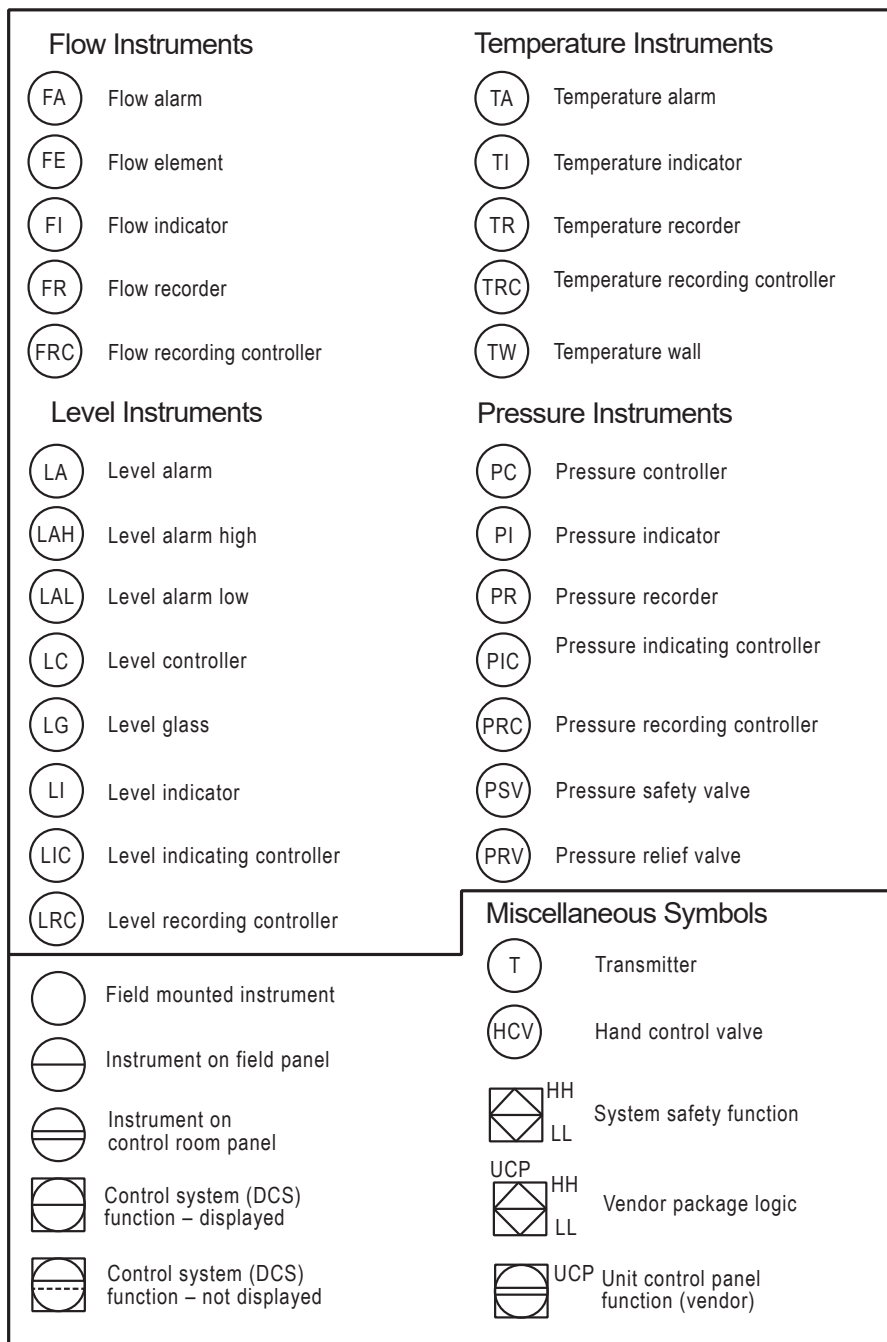
**LAH** = Level Alarm High

**LAL** = Level Alarm Low

**LG** = Level Gauge (sight glass, gauge glass)

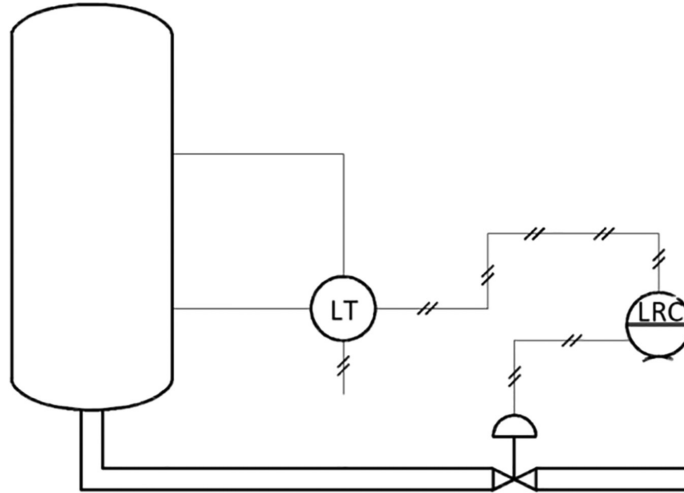


**Figure 6 – P&ID Instrumentation Symbols**



By putting together equipment, piping, and instrumentation symbols, simple control loops can be created. These are built into more complete P&ID diagrams. Figure 7 shows an example of a simple instrument loop that senses and adjusts a tank level. This is an example of an electrical single line diagram.

Figure 7 – Simple Control Loop



The pneumatic transmitter (LT) senses the tank level. Note the control lines. They indicate the control system is pneumatic. The output of the level transmitter is routed to a field panel mounted level recording controller (LRC). The level controller records the level, and sends a modified pneumatic signal to the diaphragm-operated level control valve. Notice that insufficient information exists to determine the relationship between the sensed tank level and valve operation.



## OBJECTIVE 4

Explain the use of general arrangement, block plans, and equipment diagrams.

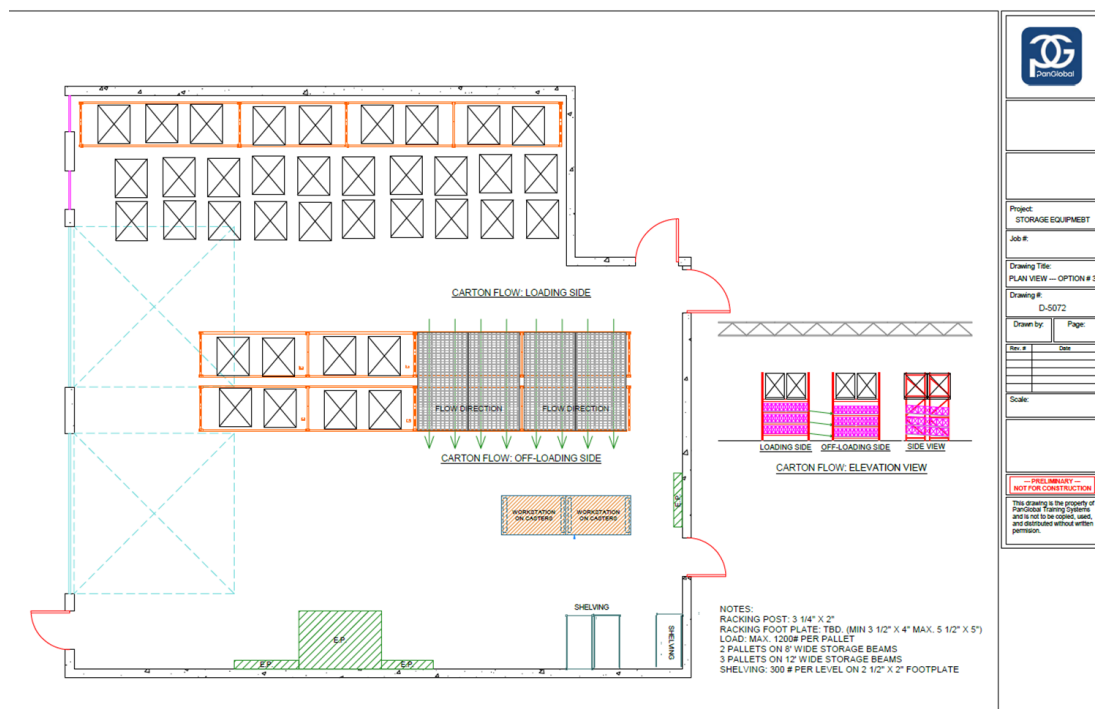
### GENERAL ARRANGEMENT (GA) DIAGRAMS

A general arrangement (GA) diagram depicts the physical relationship of significant items by using appropriate projections or perspective views. Reference dimensions may be included. A GA diagram does not identify items.

In an operating facility, a GA diagram provides a general description of the configuration and location of significant items of the plant. It is not meant to provide exact dimensional relationships. A representation of a valve on a pipeline provides its location relative to other elements of the pipeline, but not its exact location (i.e. no accurate dimensions are provided).

Figure 8 provides a GA diagram of a warehouse setup. The diagram provides a view of the warehouse shape and configuration within it. The specific reference to “carton flow” provides perspective of individual items being selected versus the pallet storage in other parts of the warehouse.

Figure 8 – Sample General Arrangement Diagram



## BLOCK PLANS

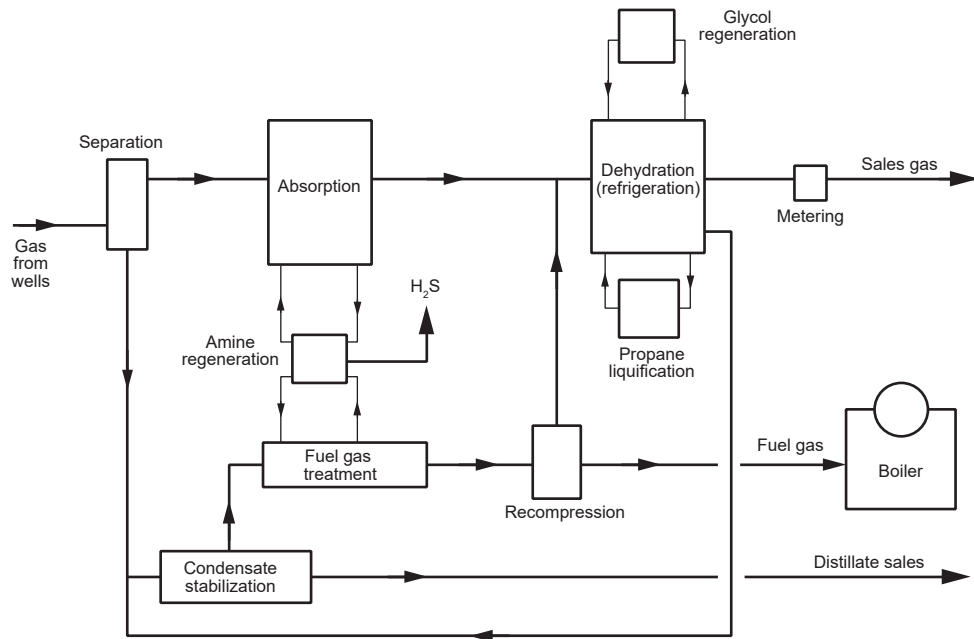
Shapes in block diagrams represent different unit operations. These blocks enclose the individual process rather than an individual piece of equipment. The block plan is an indication of the special arrangement of the equipment and systems. It does not indicate how the equipment is connected.

Use these guidelines to create clear and easy to understand block diagrams:

- Use a simple block or rectangle to denote individual units, such as mixers, furnaces, separators, reactors, distillation columns, and heat exchangers.
- Note groups of individual units by a single block, rectangle, or characteristic shape.
- Process flow streams flowing into and out of the blocks are not represented.
- Label the unit operations (i.e., blocks).
- Where possible, arrange the diagram so that the process material flows from left to right. Upstream units should be on the left and downstream units on the right.

Figure 9 shows a sample block diagram.

**Figure 9 – Sample Block Diagram**



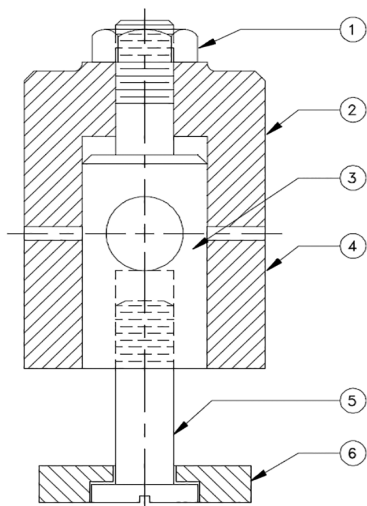


## EQUIPMENT DIAGRAMS

System level diagrams always have supporting individual equipment diagrams. These provide a detailed graphical description of the component. The equipment view can range from a simple 2D perspective, through to complicated 3D cutaways or assembly diagrams. These diagrams are meant to present a pictorial view of the individual equipment. They are used both as a design tool for fabrication, and to provide visual perspective in recognizing the component in the operating environment of the plant. Some equipment diagram examples are shown in Figure 10.

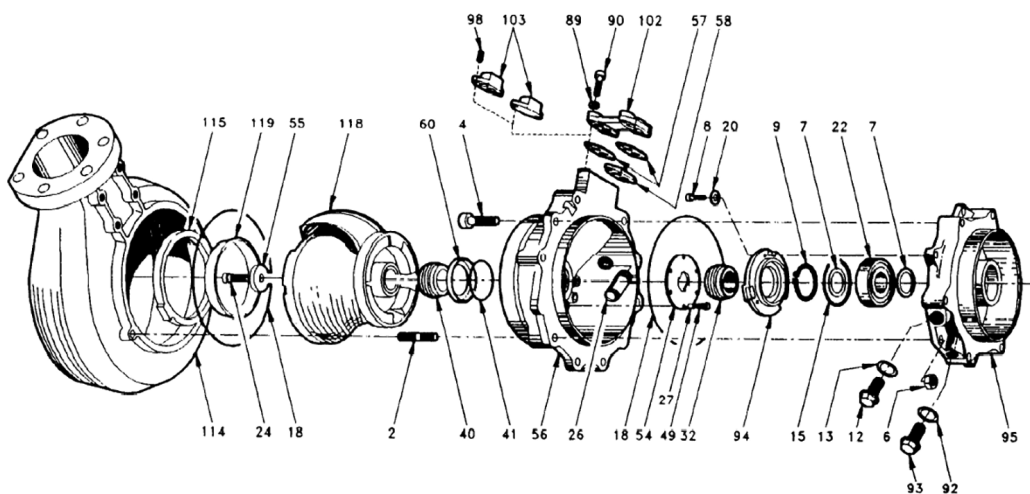
**Figure 10 – Sample Equipment Diagrams**

(a) Fabrication diagram

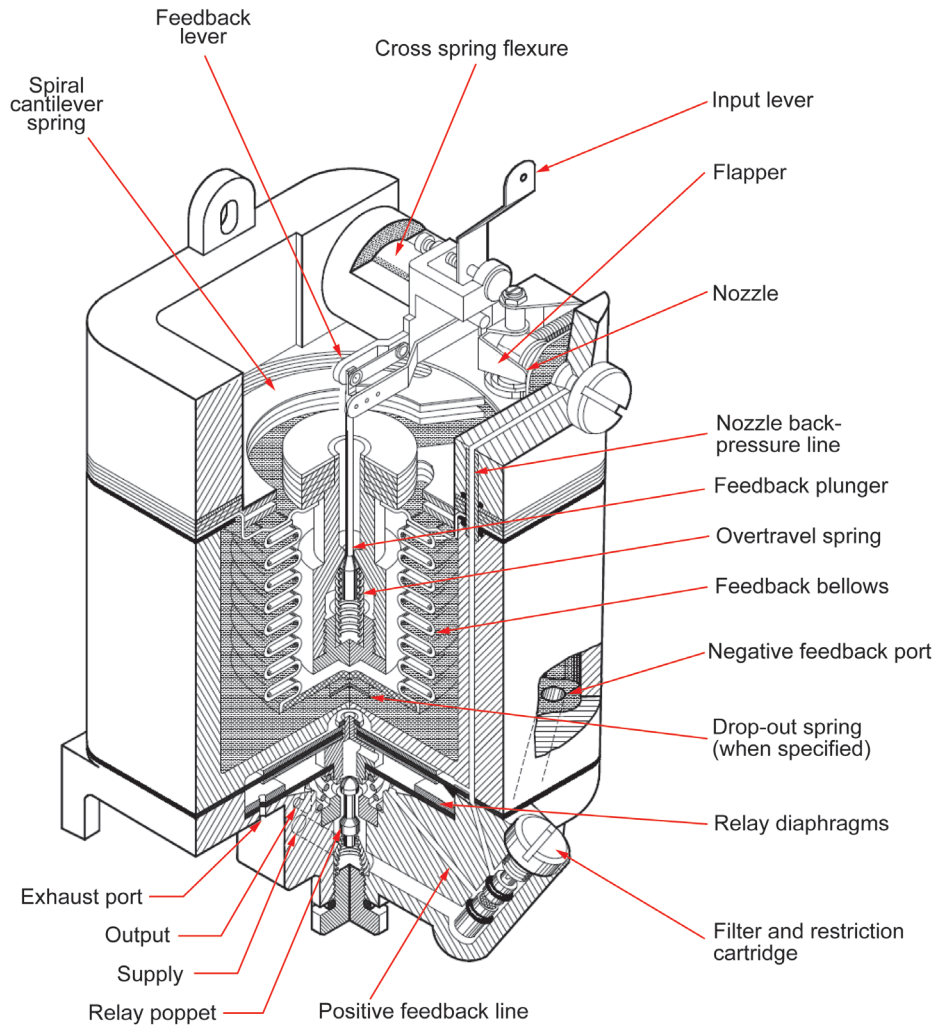


PC. NO.	NAME	DRNG. NO.	MAT'L.	QTY.
1	NUT 3/4-10 UNC-2B	PURCHASE	STEEL	1
2	UPPER BODY	1005-2	STEEL	1
3	POST	1005-3	STEEL	1
4	LOWER BODY	1005-4	STEEL	1
5	SHOULDER SCREW	1005-5	STEEL	1
6	PLATE	1005-6	STEEL	1

(b) Assembly diagram



(c) Cutaway diagram





## CHAPTER SUMMARY

Whether hand or computer generated, PFDs, P&IDs, and other plant diagrams are used throughout the life cycle of a plant. From designers and construction personnel to operations and maintenance professionals, these diagrams are valuable communication tools that help every team member understand what the plant does and how it does it.

Being able to develop those diagrams as a means of communicating with other team members is a skill that is critical in understanding the functional operations of every energy plant.





## Plant Communications

### LEARNING OUTCOME

*When you complete this chapter you should be able to:*

*Describe the types and proper usage of plant communication systems.*

### LEARNING OBJECTIVES

*Here is what you should be able to do when you complete each objective:*

- 1. Discuss effective written and verbal communication skills, including the use of two-way radios.*
- 2. Describe the legal documentation requirements for Power Engineers, including log books and log sheets.*
- 3. Discuss the elements of Maintenance Management Systems, including work requests and work orders.*
- 4. Discuss the purpose, revision, and control of Standard Operating Procedures.*
- 5. Discuss updating procedures for piping and instrumentation diagrams.*





## CHAPTER INTRODUCTION

Communication is a fundamental, interpersonal human activity. It is fundamental because humans desire interaction, and cannot survive without communication. It is interpersonal, because it occurs between persons. In the workplace, the need for communication is vital.

Communication happens because of a need to exchange information. In a power plant, much of the information exchanged is critical to the safe functioning of the plant and its equipment.

Communication is an interactive information exchange involving two or more persons. The interactive process involves both transmission and reception of ideas. A speaker or writer encodes and transmits ideas. A reader or listener receives and then decodes the transmitted ideas.

Effective communication involves both clarity of expression and active listening. Transmitters of information must encode their ideas clearly and precisely, to reduce the chance of misinterpretation. Receivers of information must read carefully, or listen actively, to reduce misunderstanding. Active listening includes reflecting back to the transmitter, and asking questions to seek clarity.

Miscommunication can occur due to faulty transmission, faulty reception, or both. When miscommunication occurs in a power plant, accidents occur, people get hurt, and equipment gets damaged.

## OBJECTIVE 1

*Discuss effective written and verbal communication skills, including the use of two-way radios.*

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## WRITTEN COMMUNICATION

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The list of the written communication forms used in power plants is endless. Such a list would likely include:

- Log book entries
- Work permits
- Operating procedures
- Job hazard analyses
- Incident reports
- Lockout tags
- Letters, e-mails, and memos
- Scaffold inspection tags
- Union contracts
- Transportation of dangerous goods dockets

Written communication is especially preferred in situations where a permanent record is required. Some of the advantages of written communication are:

- Recorded documents can be easily referenced in the future.
- Written content can be proof read, edited, and organized before delivery.
- More time can be taken to select appropriate wording, which reduces misinterpretation and misunderstanding.

Here are some practical writing tips:

- If applicable, include a subject line to help both the reader and writer to stay focused on the topic.
- Be clear by keeping the message plain and simple. Choose words that are easy to understand, and writing styles that suit a wide audience.
- Proofread before distribution. Check for grammatical errors, spelling mistakes, and misused words.
- Be precise, accurate, and direct.
- Be courteous, and avoid rude language.

It may take many years of practice to become confident and effective at written communication. Given its importance, good written communication must begin to develop early in a Power Engineer's career.

### E-mail

E-mail is a common form of written communication. E-mail combines the benefits of fast message delivery, with permanent communication records.



## E-mail Etiquette

- a) Always include a message in the “subject” line. Make sure the subject line matches the message.
- b) Only send messages to those who need it. “CC” those recipients of lesser importance.
- c) Read the entire message prior to replying.
- d) Use e-mail features such as “high importance” flags, “delivery receipts,” and “read receipts” only when necessary.
- e) Do not hit “reply all” to every message. Consciously decide who should get the reply.
- f) Use proper words or plant accepted acronyms, to ensure clarity.
- g) Review the e-mail before hitting the “send” button. Are there words or phrases that may be unclear? Is the tone professional and appropriate for the audience?
- h) DO NOT TYPE IN “ALL CAPS.” THIS IS CONSIDERED TO BE SHOUTING, AND IS USUALLY INAPPROPRIATE.
- i) Do not use company e-mail for personal business. Use private e-mail for personal use. For example, “CATS FOR SALE” is not an appropriate subject for an e-mail originating from, or arriving to, a company computer.
- j) Avoid sending large attachments. Use a shared internal folder location to share larger files.
- k) Make a phone call when there is a likelihood that the written message could be misunderstood. Provide a phone number, and suggest it be called if the e-mail message is unclear.
- l) Do not share other persons e-mail addresses indiscriminately. When e-mailing to a group, add all the recipients to the “BCC” list so that no one can see anyone else’s e-mail address.
- m) Always sign your e-mails. The recipient may not know the true identity of powerengineer321@server.org.

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## VERBAL COMMUNICATION

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Verbal communication uses spoken words. A key component of verbal communication is listening. For effective verbal communication, both speaking and listening skills are equally important.

Unlike written communication, verbal communication allows persons to express themselves with little preparation time. The communicators receive rapid feedback and clarification. For example, while following a sequence to regenerate a weak acid cation exchanger, a control room operator may rely on step-by-step reports from a field operator. The field operator can report adverse conditions, and the control room operator can begin corrective actions right away. Verbal communication produces rapid and effective responses.

Verbal communication allows co-workers to provide and receive immediate feedback and clarification, while performing or planning operational activities. This is critical for successful training of novice Power Engineers. For example, a less experienced Power Engineers may be assigned to cut steam boilers into pressurized headers. Engineers in training will be unfamiliar with the procedure, and must rely on the direct supervision of veteran engineers. The verbal interplay could include instructions on:

- How and when to open the non-return drain valve.
- When, how much, and how quickly to open the non-return valve.
- When to open the header bypass valve.
- When to open the header valve.

Feedback and clarification during the procedure could include comments like:

- “This valve over here?” “No, the small valve beside it.”
- “Is the valve open wide enough?” “No. Open it one more turn.”

In emergency situations, effective verbal communication is essential. Orders must be issued rapidly, clearly, correctly, and precisely. In these situations, only necessary communication is permitted. Verbal communications for emergency situations must be practiced regularly. Many plants have regular exercises to practice effective communication in the event of worker injury or other emergency.

Improving verbal communication skills can help to develop better relationships with family, friends, co-workers, and supervisors.

For effective verbal communication, consider the following points:

**Clarity:** Use simple, plain words to help others understand. Be precise.

**Be concise:** Express the message using the fewest words possible. Try to make a long story short, not a short story long.

**Stay focused:** Keep to the topic.

**Encourage participation:** To encourage interaction, do not dominate conversations.

**Encourage interaction:** Develop active listening skills.

**Be consistent:** Keep the same message when communicating with different recipients.

**Be sincere:** Communicate with honesty and accuracy.

**Be nice:** Always be courteous. Say “please” and “thank you,” and avoid using offensive language.

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## TWO-WAY RADIO USE

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Two-way radios are the most commonly used communication devices at industrial worksites. These radios are essentially transceivers. They transmit and receive verbal communications between operators with similar radios, using the same radio frequency channel.

Plant operators use handheld radios where mobility and portability are required. Stationary base stations are high-powered transceivers. These are located in fixed locations, such as control rooms. For this reason, the control room also often serves as the plant communication hub. Repeaters are sometimes used to extend the signal range and coverage required for larger facilities.

Two-way radios have numerous controls and functions: power switches, volume controls, push-to-talk switches, channel selectors, programmable features, and LCD displays. Before using the radio, operators must become familiar with its controls, functions, and limitations. It is very important to review the radio manufacturer’s operating manual. As well, operators must be familiar with plant Standard Operating Procedures (SOPs) for radio communication.

### Two-Way Radio Operating Tips

When using two-way radios, there are rules for acceptable behaviour, as with all forms of communication. The following are helpful operating tips.

- a) Ensure the radio battery is fully charged at the beginning of the shift, and that the power is on.
- b) At the end of the shift, place the radio or its battery in the charger. This ensures that fully charged batteries and radios are always available.
- c) Adjust the volume to suit the work environment. Turn up the volume if working around machinery.



- d) Do not start talking until the push-to-talk switch is fully depressed.
- e) Check that the correct people are being communicated with. It is possible that operators, maintenance crews, and contractors are on different channels:
  - i. Note the channel setting on the radio or base station channel selector switch.
  - ii. Call another member of the crew to perform a verbal communication check.
- f) If the handheld radio is equipped with a “Man-Down Button” (small RED button on the top or side of the radio), take precautions to prevent activating it accidentally.
- g) Make sure the “Talk” button on the handheld radio is not accidentally engaged, especially when sitting down or leaning against another object.
- h) Check signal strength regularly to make sure the radio is functioning properly, and the radio is still in range of the base. To do this, call out “radio check” on a regular basis. A response of “loud and clear” or “five by five” means “perfect transmission.” A response of “four by four” means “good transmission,” and so on.
- i) Be sure the radio is in good working condition, and check its operation regularly.

## Two-Way Radio Etiquette

### Be Courteous

Wait until the current conversation is finished before calling in. Unlike a telephone, a two-way radio does only one function at a time; it either transmits or receives. While the push-to-talk switch is pressed, the radio can only transmit. When the push-to-talk switch is released, it can only receive. Release the push-to-talk switch to hear an incoming message.

### Be Sure

To begin speaking, press and engage the push-to-talk switch. Finish speaking before releasing it.

### Be Clear

Always identify yourself. Speak clearly and slowly with a normal tone. Speak closely into the microphone. Shield the microphone from external noises. Do not shout.

### Repeat Back Instructions

When asked to complete a task, repeat an instruction back to confirm that it was heard correctly.

### Be Selective

Use the radio only when necessary.

### Be Simple

Keep messages simple, precise, and to the point for easy understanding.

### Be Secure

Do not share confidential information over the radio. Everyone on the same channel hears the transmission.

### Be Nice

Do not use foul language.



## Two-Way Radio Language

Two-way radio language uses terminology that is different from common spoken English. Many of these terms are derived from maritime or military two-way radio communications.

To avoid confusion for the novice operator, Table 1 shows some commonly used two-way radio terms, with brief descriptions of what they mean.

<b>Term</b>	<b>Meaning</b>
<b>Affirmative</b>	"Yes," or "That is correct."
<b>Check</b>	"Radio check"
<b>Come Again</b>	"Please repeat the message."
<b>Come In</b>	"Please respond." (as in "Come in, Control Room.")
<b>Copy That</b>	The message is understood.
<b>Five by Five</b>	The radio transmission is strong and clear. (Said in response to a radio check.)
<b>Go Ahead</b>	"I am ready to listen to you."
<b>Loud and Clear</b>	The radio transmission is strong and clear. (Said in response to a radio check.)
<b>Negative</b>	"No"
<b>Out</b>	The conversation is finished.
<b>Over</b>	The radio transmission is finished.
<b>Roger That</b>	The message is received and understood.
<b>Standby</b>	The message is acknowledged and placed on hold.
<b>Ten Four</b>	Same as "Roger That"
<b>Emergency, Emergency, Emergency</b>	This is said to interrupt all radio communications due to an emergency. Another term sometimes used is "Break, Break, Break".

## Phonetic Alphabet

There are many times when operators must report readings from field instruments to control room operators, using two-way radios. For example, a pressure vessel may have four pressure transmitters, tagged PT502A, PT502B, PT502C, and PT502D respectively. The control room operator may need the reading from PT502D. The letter "D" may sound like "B" (especially when spoken in a noisy environment, or by persons for whom English is not their first language). For this reason, the control room operator would ask for the reading from "PAH-PAH, TANG-GO, FIFE, ZEE-RO, TOO, DELL-TAH," to eliminate confusion.

Table 2 shows the common way of distinguishing letters when using two-way radios. Similar lists have been developed in Great Britain and the USA at different times over the last 100 years. However, the terms in Table 2 are currently used by the North American Treaty Organization (NATO), and they have become the most common. If all workers use the same phonetic alphabet, miscommunication will be minimized.

**Table 2 – NATO Phonetic Alphabet**

	Phonetic Term	Pronunciation		Phonetic Term	Pronunciation
<b>A</b>	Alpha	AL-FAH	<b>N</b>	November	NO-VEM-BER
<b>B</b>	Bravo	BRAH-VOH	<b>O</b>	Oscar	OSS-CAH
<b>C</b>	Charlie	CHAR-LEE	<b>P</b>	Papa	PAH-PAH
<b>D</b>	Delta	DELL-TAH	<b>Q</b>	Quebec	KEH-BECK
<b>E</b>	Echo	ECK-OH	<b>R</b>	Romeo	ROW-ME-OH
<b>F</b>	Foxtrot	FOKS-TROT	<b>S</b>	Sierra	SEE-AIR-RAH
<b>G</b>	Golf	GOLF	<b>T</b>	Tango	TANG-GO
<b>H</b>	Hotel	HOH-TEL	<b>U</b>	Uniform	YOU-NEE-FORM
<b>I</b>	India	IN-DEE-AH	<b>V</b>	Victor	VIK-TAH
<b>J</b>	Juliet	JEW-LEE-ETT	<b>W</b>	Whiskey	WISS-KEY
<b>K</b>	Kilo	KEY-LOH	<b>X</b>	X-Ray	ECKS-RAY
<b>L</b>	Lima	LEE-MAH	<b>Y</b>	Yankee	YANG-KEY
<b>M</b>	Mike	MIKE	<b>Z</b>	Zulu	ZOO-LOO

Table 3 shows the NATO phonetic pronunciation for numbers. Again, this system is used to reduce communication errors.

**Table 3 – NATO Phonetic Pronunciation of Numbers**

	Pronunciation		Pronunciation
1	WUN	6	SIX
2	TOO	7	SEV-EN
3	TREE	8	AIT
4	FOW-ER	9	NINER
5	FIFE	0	ZEE-RO

## OBJECTIVE 2

*Describe the legal documentation requirements for Power Engineers, including log books and log sheets.*

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### LOG BOOKS

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Log books help to document regular activities. Power Engineers must maintain steady operating conditions, attempt to normalize process conditions when disturbances occur, and respond to emergency situations. Because Power Engineers have so much responsibility, it is necessary for them to document the:

- a) Equipment they observe or test.
- b) Results of the equipment tests.
- c) Maintenance performed in the plant.
- d) Process disturbances or unusual conditions that occur.
- e) Decisions made:
  - i. Regarding the results of equipment tests.
  - ii. Due to the occurrence of unusual conditions.
- f) Orders given with respect to observed conditions.
- g) Actions taken while on shift.
- h) Final results of the actions taken.

The shift engineer is usually responsible for documenting this information.

The timing of all the activities on shift must also be well documented. When Power Engineers are conscientious, choose wisely, follow plant procedures, and act in a timely manner, processes remain stable and safe. However, process upsets and outages do occur, even to well-qualified and experienced operators.

When process upsets occur, operators can use log books to demonstrate that they took reasonable steps, followed approved procedures, and acted in reasonable amounts of time, to normalize process conditions. The logs can be used to re-examine and revise procedure manuals, to address how similar situations should be handled in the future.

Log books are very useful for transferring information during shift changes. The incoming shift needs to be prepared for the conditions they will encounter. Is a shipment of chemicals due? Is it time to transfer over feed pumps? Will the plant be switching to standby fuel? Are the fire alarms being tested? Does the demineralizer need regeneration? Is maintenance replacing a chilled water pump seal? Has the process stabilized after a power outage? Without this information, the incoming shift will be surprised by the conditions they encounter, and may not react appropriately or promptly to situations that need their attention.

Log books help to inform operators of operating trends. This includes energy usage and cost, plant and boiler efficiency, and boiler fireside cleanliness. When used over a period of time, log books document equipment operation and maintenance history. When plant maintenance is performed, log books briefly summarize the work performed, who did the work, and why the work was necessary. This is useful for changes in operational staff, maintenance staff, and ownership.



Log books are more than just ways of documenting activities and informing shift changes. Every Canadian jurisdiction requires Power Engineers to make log entries every shift, and then to sign and date each entry. Operators who do not make the required entries contravene the law, and may be found guilty of an offense. Therefore, it is important to think of log books as legal documents that can and will be used to determine culpability in a court of law. Who was operating at the time of the accident? What were the conditions observed by the operator? What was the sequence of events, and when did they occur? What decisions did the operator make? What were the orders issued by the operator? What were the outcomes of the orders that were issued? How often were tests conducted?

With careful documentation, boiler inspectors and safety officers can examine operator behaviours, and determine responsibility should a significant hazardous event occur. Log books must be made available to jurisdictional inspectors upon request. As well, log books should be kept for a minimum number of years, as prescribed by the jurisdiction.

### Good Practice for Log Book Entries

Because log books are legal documents, entries must be legible, accurate, and concise. The following list covers additional good practice.

- a) Use ONLY official plant log books. Do not make official log entries on scrap paper or in personal notebooks.
- b) Write legibly, in permanent black ink.
- c) Make log book entries as the opportunity arises. It is possible to forget events or times, if waiting for the end of the shift.
- d) Record the time of each event entered in the log book. Use the 24-hour clock to indicate times. Entries in the record must be in chronological order.
- e) Make sure to note significant equipment, plant areas, workers, orders given and received, tests, and actions taken.
- f) Write only facts. Do not enter opinions.
- g) NEVER erase entries.
- h) NEVER remove pages from the log book.
- i) Try not to leave large blank spaces. Draw diagonal lines through large spaces, where they occur. Initial and date the diagonal line. This indicates the vacant space is deliberate, and should not have content.
- j) If a mistake is made, draw a single line through the text. Initial and date the line. NEVER use correction fluid or correction tape.
- k) Sign and date all entries at the end of the shift.



## LOG SHEETS

To help Power Engineers document the tests they perform and the observations they make, log sheets are often used. Small hot water heating plants may have only a single log sheet for the boiler. Steam heating plants may have separate log sheets for the boiler and for water tests (Figure 1). The operator conducting the checks initials each entry. If unusual conditions exist, a brief entry is made in the comments area. Circumstances surrounding the unusual condition are described with more detail in the log book.

**Figure 1 – Steam Heating Boiler Log Sheet**

STEAM HEATING BOILER LOG (based on ASME VI and CSD-1)																																
<b>Maintenance, Testing and Inspection Log</b>		Building:		Month:		Year:																										
<b>Steam Heating Boilers</b>		Address:		Fuel Type:		Boiler Type:																										
Persons to be Notified in Emergency (Name and Telephone No.)																																
<b>DAILY CHECKS</b>																																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	
1) Observe Water Level																																
2) Record Pressure																																
3) Record Flue Gas Temperature																																
4) Check Burner Flame																																
5) Check Gauges and Indicators																																
6) Check Set Points																																
<b>WEEKLY CHECKS (Enter Date)</b>																																
	WEEK 1							WEEK 2							WEEK 3							WEEK 4										
1) Test Low Water Cutoff																																
2) Test Gage Glass																																
3) Observe Flame Condition																																
4) Check Flame Signal Strength																																
5) Check Flame Failure Detection System																																
6) Check Firing Rate Control																																
<b>MONTHLY CHECKS (Enter Date)</b>																																
1) Manual Lift Safety Valve																					(A) Linkages											(F) Low-Fire Start Interlock
																					(B) Damper Controls											(G) Draft Fan Interlocks
2) Review Condition of or Test Each Item																					(C) Stop Valves											(H) Fuel Pressure Interlocks
																					(D) Refractory											(I) Fuel Temperature Interloc
																					(E) Flue-Chimney Breaching											(J) Operating Controls
3) Inspect Fuel Piping																																
4) Combustion Air Adequate/Unobstructed																																
General Comments:																																



Large plants have log sheets for each part of the plant. For example, the steam plant will have one log sheet for the boiler and another for boiler water tests. The turbine operator will have a log sheet for the turbine and turbine auxiliaries. The water treatment plant operator will have a log sheet for external (boiler feed) water tests. Figure 2 shows a sample water treatment log sheet.

**Figure 2 – Water Treatment Plant Log Sheet**

Water Treatment Plant Tests		Date:				
		Engineer:	Days:	Nights:		
<b>Chemical Feed Rates</b>	<b>8:00</b>	<b>12:00</b>	<b>16:00</b>	<b>20:00</b>	<b>0:00</b>	<b>4:00</b>
Polymer (ml/min)						
Pacifier (ml/min)						
Lime (pump setting)						
MagOx (pump setting)						
Soda Ash (ml/min)						
Caustic (ml/min)						
<b>Warm Lime-Soda Reactor</b>	<b>8:00</b>	<b>12:00</b>	<b>16:00</b>	<b>20:00</b>	<b>0:00</b>	<b>4:00</b>
pH						
Soluble Hardness						
Acidified Hardness						
P Alkalinity						
M Alkalinity						
OH Alkalinity						
Upper Sludge Volume (%)						
Middle Sludge Volume (%)						
Lower Sludge Volume (%)						
Cleanwell Silica						
Cleanwell Turbidity						
<b>Carbon Filters</b>	<b>8:00</b>	<b>12:00</b>	<b>16:00</b>	<b>20:00</b>	<b>0:00</b>	<b>4:00</b>
Turbidity						
Soluble Hardness						
Acidified Hardness						
<b>Ion Exchange Softeners</b>	<b>8:00</b>	<b>12:00</b>	<b>16:00</b>	<b>20:00</b>	<b>0:00</b>	<b>4:00</b>
On-Line Softener (1 or 2)						
Primary Softener Hardness						
Polisher Hardness						
Silica						
Totalizer						
Flow (l/min)						

Log sheets can help operators and maintenance personnel to diagnose problems with equipment or processes. Log sheets can be used to compare how equipment operates when new, after being repaired, or after being in-service for a period of time. This informs equipment maintenance activities and replacement scheduling.

Most importantly, log sheets inform operators of the decisions made on previous shifts; the process conditions and trends that led to the decisions; and the results of those decisions. For example, an operator may notice that over the previous shift, the boiler M-alkalinity fell steadily. On further observation, the operator may notice that the continuous blowdown valve setting was increased by 10% in response to high dissolved solids. The operator may then choose to adjust the continuous blowdown back to its previous setting, depending on the most recent dissolved solids concentration.

Power Engineers must recognize that, like log books, log sheets are legal documents, because log sheets support and verify the information recorded in log books. The same care in using log books should extend to the use of log sheets.

## OBJECTIVE 3

*Discuss the elements of Maintenance Management Systems, including work requests and work orders.*

A Maintenance Management System (MMS) is used to organize, plan, monitor, and evaluate maintenance activities. A well-functioning MMS is essential for:

- Optimizing plant efficiency and safety
- Minimizing environmental impact
- Keeping costs at reasonable and manageable levels

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## TYPES OF MAINTENANCE

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Maintenance can be classified as follows:

**Routine** – Routine maintenance consists of regular scheduled tasks (daily, weekly, or monthly) associated with the continuous operation of a facility. Routine maintenance may include brief operation of standby pumps; placing engines on barring gear; checking the operation of smoke detectors and emergency lighting; and checking battery fluid levels.

**Preventative** – Preventative maintenance involves the systematic inspection, detection, and correction of conditions, to prevent equipment failure. This may involve scheduled pump shaft alignment; checks of pulley alignment and gear lash; air filter replacement; vibration analysis; and testing of various fluids (such as oils and coolants).

**Projects** – Projects are planned activities, such as the relocation of a control room. Projects involve both plant personnel and contractors. Detailed planning and organization is necessary for successful project completion. Smaller projects, like boiler room pipeline labeling, often involve only plant personnel, and have far fewer details.

**Emergency** – Emergency maintenance involves unplanned and unscheduled events, such as sudden equipment mechanical failure. Sometimes, emergency maintenance is necessary due to the effects of hostile natural conditions (such as strong winds or flooding).

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## KEY COMPONENTS OF AN MMS

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The following are key components of an MMS:

- a) An inventory program that accurately tracks maintenance costs, repairs, and other expenses associated with physical assets (such as buildings, roads, and equipment).
- b) Analyzes and documents the types, durations, and frequencies of maintenance activities needed for each piece of equipment in the plant.
- c) Provides an annual maintenance work schedule based on the information collected.
- d) Handles work requests, and issues work orders.
- e) Creates a realistic budget for all associated maintenance costs. These include such costs as internal labour, contract labour, parts, consumables, and equipment rentals.

Emergency maintenance and repairs are impossible to predict. Maintenance plans may include labour, budget, and materials contingencies to deal with unexpected events.



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## WORK REQUESTS AND WORK ORDERS

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Work request systems are integrated with maintenance management systems. In power plants, very little maintenance or repair work is done without being formally requested. By tracking the work performed, companies learn the cost associated with maintenance and repair, and can use this information to accurately budget for upcoming expenses. For this reason, most plants have some system of requesting work.

When a work request is submitted, it triggers many, if not all of, the following activities:

- a) Determining the costs for labour, parts, and consumable materials
- b) Planning and prioritizing work
- c) Scheduling labour for the:
  - Engineering department
  - Design department
  - Maintenance department
  - Operations department
  - Inspections department
  - Outside contractors
- d) Warehouse activities:
  - Ordering parts, specialized tools, and equipment
  - Receiving
  - Placing into inventory
- e) Accounting activities:
  - Administering contracts

Work requests can originate from individuals working in various departments, such as operations, maintenance, information technology, and engineering. The work requested may be an equipment test, a process performance evaluation, a repair, an installation, an inspection, a replacement, or a renovation.

Typical work orders include the following information:

- a) Name, department, and title of the person making the request
- b) Name of an authorizing individual (the person who approved the request)
- c) Location of work to be performed
- d) Equipment number or designation
- e) Scope of work (description)
- f) Work permits required (such as hot work, confined space, and excavation)
- g) Trades department to be assigned, or operations department
- h) Specialized equipment, tools, or materials needed
- i) Type of outside contractor or specialized tradespersons required
- j) Justification of the work
- k) Date request was submitted
- l) Date the work must be completed
- m) Priority (safety concern, urgent, high, medium, or low)





Next, the request form is sent to a maintenance planner. The planner considers and organizes all aspects of the job. Routine maintenance tasks are usually scheduled by the planner, and work orders are generated automatically by a maintenance planning software package. For this reason, work requests are not usually submitted for routine maintenance. However, non-routine maintenance (such as repairing leaky pump seals or replacing non-functioning valves) always require work requests.

Every work request is unique. Many jobs require new or modified designs, and engineering approval. Sometimes, heavy lifts that involve cranes and crane operators must be planned. Confined space entry can involve specialized safety equipment. Additional contracted safety watch personnel may be required during the confined space entry. Parts or replacement equipment must be specified and ordered by warehouse personnel. Some large jobs require plant shutdown, and are scheduled for a turnaround period. Substitution of parts or equipment, as well as changes to existing designs, must be approved through the engineering departments' Management of Change (MOC) procedures. The planner co-ordinates and routes all tasks and sub-tasks for every work request.

After work requests have been scheduled by the planner, work orders are assigned to the appropriate tradespeople, operators, technicians, or contractors. The work order outlines the scope of the work, and provides all supporting documents (such as piping and instrumentation diagrams).

Before proceeding with the job, the assigned person must receive a work permit and all other supporting permits. The operations department issues these permits. A site inspection is performed when the job is completed. The worker signs-off and surrenders the work permits to the operations staff. Successful completion of the job is then relayed back to the maintenance planner, who completes the documentation.



## OBJECTIVE 4

*Discuss the purpose, revision, and control of Standard Operating Procedures.*

A standard is a way of dealing with repetitive activities in a consistent fashion. Standard Operating Procedures (SOPs) are operating instructions for performing routine tasks consistently. These instructions cover a wide variety of plant activities, such as starting an air compressor, cutting a steam boiler into a pressurized header, testing boiler water, or regenerating an ion exchange softener.

SOPs are developed by considering:

- Equipment manufacturer operating manuals
- Overall process design parameters (such as pressures, temperatures, and flows)
- Potential for environmental impact
- Job hazard analyses and safety audits

SOPs are usually developed by a joint effort between field operators, control room operators, plant managers, plant safety officers, and maintenance staff. Once an SOP is developed and agreed upon, it is submitted to management for final sign-off. Then, all employees must follow the SOP.

SOPs help to maintain product quality, workplace safety, and environmental compliance. Other benefits include:

- a) Maintains quality, safety, and environmental standards, even when the personnel changes.
- b) Catalogues procedures. This helps with worker training.
- c) Helps to eliminate or reduce miscommunication.
- d) Documents historical operating data for future reference.
- e) Helps to develop checklists for inspectors or auditors as part of the auditing and approval processes.

### SOP Writing Tips

- a) Use standard company templates for all new or revised procedures. Standard SOP templates should be used throughout the organization.
- b) Select the best person to write the procedure. Who is the most familiar with the process, and competent at performing the procedure?
- c) If the procedure involves starting or stopping machinery, incorporate the manufacturer's operating instructions, to ensure safe operation and long equipment life.
- d) Test the procedure to verify it actually works. In addition, have a number of people (other than the writer), who are qualified but have never done this procedure before, to verify the steps.
- e) Those who will be working with the procedure, as well as the safety and quality assurance advisors, must review the proposed SOPs. Select one of the best-suited people from this group as an official reviewer.
- f) After review and sign-off the proposed SOP, it then goes for final approval. Designation of the official approver will vary within different organizations, based on their practices. Generally, assignment of this function goes to the work process owner. For example, the Heating Plant Operations Manager often becomes the approver for all plant related SOPs.
- g) Begin implementation of the SOP after final approval.



## Format of Standard Operating Procedures

Despite variations from company to company, SOPs tend to include many of the same elements. SOPs usually begin with a header containing information like that shown in Table 4.

**Table 4 – Standard Operating Procedure Title Box**

Standard Operating Procedure	
<b>Company Name:</b> Canadian Natural Forest Products	<b>Location:</b> Dogtooth Operations
<b>Standard Operating Procedure Number:</b> GT-0021	<b>Revision:</b> 08
<b>Title:</b> Alkalinity Testing	
<b>Department:</b> Water and Wastewater	<b>Form:</b> W-521
<b>Effective Date:</b> 09-01-2015	<b>Date Issued:</b> 08-01-2017
<b>Prepared By:</b> Greta Nordberg, Water Plant Lead	<b>Date Prepared:</b> 08-25-2015
<b>Signature:</b>	
<b>Revised By:</b> Derek Fontaine, Control Room Operator	<b>Date Revised:</b> 05-26-2017
<b>Signature:</b>	
<b>Reviewed By:</b> Les Giesbrecht, Plant Safety Officer	<b>Date Reviewed:</b> 07-11-2017
<b>Signature:</b>	
<b>Approved By:</b> Larry Barker, Plant Superintendent	<b>Date Approved:</b> 07-11-2017

After the header, the SOP contains sections like the following:

1. **Background** – This section describes the historical need for the procedure.
2. **Purpose** – The purpose and rationale of the procedure are described.
3. **Scope** – Other areas of the company that are affected by this procedure are identified.
4. **Materials and Tools Requirement** – The tools and materials required for this procedure, as well as personal protective equipment, are listed.
5. **Safety Concerns and Risks Factors** – Here, hazards of the procedure are identified, such as working at heights, vehicular traffic, confined spaces, and exposure to chemicals.
6. **Environmental Considerations** – This is a list of the work conditions such as temperature extremes, wind, limited ventilation, and air circulation.
7. **Responsibilities** – The job titles of those who are responsible for carrying out the procedure.
8. **Definitions** – These are the technical terms and definitions related to the procedure.
9. **Procedure** – This is the longest part of the SOP. Listed here is the sequence of steps, tasks, and activities associated with the procedure.
10. **References** – This section lists internal and external documentation including policies, standards, codes, and regulations used to support this procedure.

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## DOCUMENT CONTROL AND REVISION

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Large plants often have hundreds, if not thousands, of SOPs. Typically, they are printed, organized, and stored in three ring binders. SOPs are carefully controlled, to prevent unauthorized changes. There are limited numbers of SOP binders (sometimes only two or three) made accessible to operations and maintenance staff. These “controlled copies” are located in places like the plant superintendent’s office, the control room, and the permit office. These are the only locations where workers can access official procedures.



### CAUTION

Never use uncontrolled SOPs. They may be incomplete, incorrect, out-of-date, or unapproved. Use of uncontrolled SOPs can adversely affect production and create unsafe conditions.

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This system of document control works relatively well in conjunction with a functioning update, revision, and approval process, particularly in smaller organizations. In recent years, though, electronic copies of SOPs are commonly kept on corporate shared drives. Users may have access to SOPs and may make unauthorized changes. Because of this, it is vitally important to restrict editing access to electronic copies of SOPs only to key individuals. These persons are directly responsible and involved with document control, preparation, revision, review, and approval.

The following are some common document control principles:

- a) Companies should have standardized document control systems, and have system administrators who maintain and circulate the documents.
- b) Companies must keep SOPs current by reviewing them at regular intervals. Risk Assessment Matrices are used to decide how often SOPs are reviewed. Critical SOPs are reviewed more frequently. SOPs for less critical tasks are reviewed less frequently. SOPs are also updated and revised whenever there is an equipment or process change, regardless of the review schedule.
- c) Companies should only circulate a limited number of printed copies. Each will have a proper document control number assigned to it. Copies must be located only in designated areas. SOPs are controlled documents; operators and maintenance staff must not be permitted to print personal copies.
- d) Companies must replace revised SOPs (both printed and electronic versions) immediately after a revision is approved. Outdated printed copies must be destroyed. Outdated electronic copies must be archived on the file storage system.



## OBJECTIVE 5

*Discuss updating procedures for piping and instrumentation diagrams.*

Piping and instrumentation diagrams (P&IDs) are important communication tools for operators, tradespeople, plant administration, and engineers. P&IDs have several uses, some of which are listed below:

- Troubleshoot process abnormalities
- Communicate process information to designers, consultants, technicians, and vendors that work off-site
- Determine equipment lockout requirements
- Operator training
- Worker safety

P&IDs are first developed early in the plant design stage. Revisions are made after initial review by process engineers and safety auditors, and then again during construction. Once construction and commissioning is complete, final versions (referred to as “As-Built” drawings) are developed. These become the first piping and instrumentation drawings authorized for use in the plant.

P&IDs must be continually updated as plant configurations change. Reasons for such changes include the following:

- a) **Process equipment is modified** when components fail, wear out, or become obsolete.
- b) **Plants grow in capacity**, resulting in new processes and new equipment being tied-in to existing process lines.
- c) **Processes are optimized** by adding, moving, or removing equipment, and making piping system modifications to suit the changes in material flow.

Even small equipment changes make original as-built drawings obsolete. For example, when hand valves are substituted for different makes, models, materials of construction, or valve type, the P&IDs no longer correctly reflect the installation. Similarly, P&IDs become obsolete when a resistance temperature sensor is substituted for a thermocouple, when a drain or vent line is added to a process line, or when a different type of steam traps is substituted for an existing trap. Because they are important communication tools, P&IDs must be kept current.



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## PROCEDURE FOR UPDATING P&IDS

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Procedures must be in place for updating plant diagrams, and they must be followed. These procedures vary from plant to plant. However, update procedures have many common elements.

One key element is the creation of an official, authorized master P&ID set. This set is the most current and most accurate revision. It is “owned” by an individual authorized to make revisions. Plants typically have three master sets:

1. **The electronic master**, in native design format (a CAD drawing) and kept in a secure location. This file set is only accessible to the owner and the owner’s designate. This set can be modified only with the owner’s approval.
2. **The print master**, in secure pdf format and kept in a shared network location. This set is accessible to individuals for printing and personal use. These files cannot be edited.
3. **The hard copy**, which is a printed set kept by the owner. This is a printout of the electronic master set, which may or may not include markups (changes not yet incorporated in the electronic master). Employees can check their printed copies against the hard copy to see if there are any process changes.

It is important for all three of these sets to be made current, and to be updated, simultaneously.

The process for revising P&IDs is typically as follows:

1. Plant personnel (especially operators) trace equipment lines in specified plant areas. They then compare them to the actual piping and instrumentation with the print master, and document any changes with red ink on the print master. This is referred to as “red-lining.” Some of the changes operators look for are:
  - a) Replaced fittings, such as valves or steam traps
  - b) Altered pipe tie-in locations
  - c) Added or deleted piping, vents, drains, or tie-in points
  - d) Added or deleted instruments
  - e) Change in instrument type
  - f) Relocation of equipment
2. After the P&IDs are “red-lined,” they are submitted to the owner of the master sets. Here, the redlined drawings are compared to the hard copy set.
3. Previously unrecorded changes are brought to the attention of the persons responsible for the process area under review. If the changes are acceptable, they are made to the hard copy. The hard copy is then used to update the electronic master set.
4. When the electronic master set is revised, it is marked with a revision number. The latest revision becomes the official authorized set of drawings. When the electronic master is revised, the print master and hard copy are also revised.

SOPs that refer to plant diagrams must be updated when plant diagrams are updated.



## CHAPTER SUMMARY

Communication arises from a need to exchange information. In a power plant, much of the information exchanged is critical for the safe and efficient operation of the plant. Therefore, information must be communicated accurately and with no room for misinterpretation.

Both written and verbal forms of communication are interactive information exchanges, involving both transmission and reception of ideas. Those who are transmitting the information must state their ideas clearly and precisely, to reduce the chance of misinterpretation. Those who are receiving the information must read carefully, or listen actively, to reduce misinterpretation. Active listening includes repeating back to the transmitter, and asking questions to seek clarity.

Verbal communication is necessary when communication must be instantaneous. To eliminate miscommunication when communicating verbally, phonetic alphanumeric pronunciation systems have been developed. As well, a special vocabulary, and certain etiquette rules, are applied when using two-way radios.

Written forms of communication include e-mails, log books, log sheets, maintenance requests, SOPs, and P&IDs. Log books and log sheets directly fulfill legal obligations. All other written documents, including maintenance requests, work orders, e-mails, SOPs, and P&IDs may be summoned as evidence in a court of law. Therefore, written communication must be accurate, thorough, and carefully completed. For the same reason, SOPs, and P&IDs must be carefully controlled, and diligently kept up-to date.

All instances of communication must be professional. Communicators must always be focused, concise, accurate, and polite.





## UNIT SUMMARY

This concludes of the Communications unit. The following topics were outlined, discussed, and illustrated:

- Energy Plant Sketching
- Plant Diagrams
- Plant Communications

This unit emphasized the communication tools and skills that a Power Engineer needs to acquire in order to become an effective member of the plant's operating team. There was an emphasis on how to make simple hand sketches, and how to recognize, use, and interpret the standardized symbols seen in plant diagrams like PFDs and P&IDs.

A self-assessment tool is available on MyPower LMS. Login using the unique user ID and password found on the inside front cover of Unit 1.









4th Class Edition 3.5 • Part A  
**UNIT A-10**

## ***KNOWLEDGE EXERCISES AND UNIT GLOSSARY***

<b>Chapter 1</b>	<b>Energy Plant Sketching</b>	<b>U10-9</b>
<b>Chapter 2</b>	<b>Plant Diagrams and Drawings</b>	<b>U10-11</b>
<b>Chapter 3</b>	<b>Plant Communications</b>	<b>U10-15</b>
<b>Unit A-10</b>	<b>Unit Glossary</b>	<b>U10-21</b>





## KNOWLEDGE EXERCISES – CHAPTER 1

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Instructor: \_\_\_\_\_ Course: \_\_\_\_\_

### Objective 1

1. Identify two ways to successfully hand sketch a circle.

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2. What important characteristic does dimensioning supply to a basic sketch?

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### Objective 2

3. What are the six possible views used in an engineering diagram?

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### Objective 3

4. In a sectional drawing, how is refractory and steel differentiated in a boiler shell?

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### Objective 4

5. Draw the following symbols: turbine, flow indicator, pump, temperature recorder.



## Chapter 1 (Cont.)

### Objective 5

6. Without any in-plant guide, on a plant piping diagram, what would the following labels indicate?
  - a. White Lettering on Green background
  - b. Black Label on Orange background
  - c. White Label on Brown Background

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7. Line tracing sample: Prepare a detailed sketch of the gas train pictured below. Identify the important components.





## KNOWLEDGE EXERCISES – CHAPTER 2

Name: \_\_\_\_\_ Date: \_\_\_\_\_

Instructor: \_\_\_\_\_ Course: \_\_\_\_\_

### Objective 1

1. What are the advantages of a plant diagram that is drawn to scale?

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2. What is the difference between a revision cloud and a triangle or circle?

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### Objective 2

3. What should be indicated regarding the process lines in a PFD?

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### Objective 3

4. What are the important differences between the PFD and P&ID diagrams?

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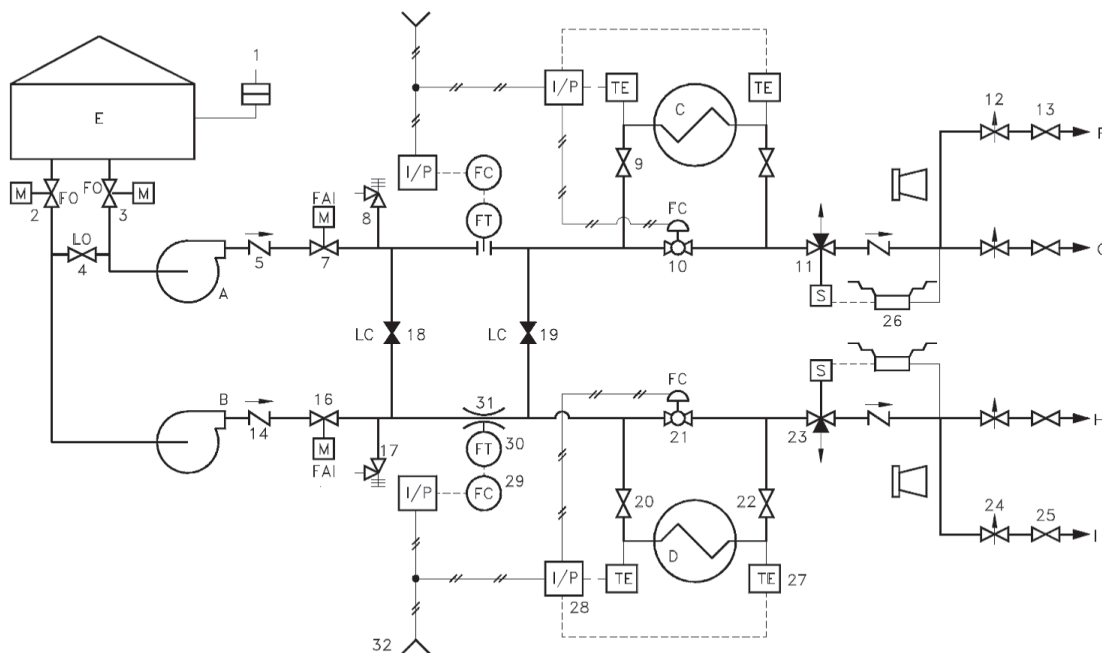
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## Chapter 2 (Cont.)

5. In the following P&ID, identify the following components by letter or number.
- Centrifugal pump
  - Heat exchanger
  - Tank
  - Venturi
  - Rupture disc
  - Relief valve
  - Motor-operated valve
  - Air-operated valve
  - Throttle valve
  - Conductivity cell
  - Air line
  - Current-to-pneumatic converter
  - Check valve
  - A locked-closed valve
  - A closed valve
  - A locked-open valve
  - A solenoid valve





## Chapter 2 (Cont.)

### Objective 4

6. When would an operator want to create a GA diagram?

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### Chapter 3 (Cont.)

3. List five important tips for using two-way radios.

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4. What two-way radio expression is used to express the following ideas?

"Yes," or "That is correct."	
"Radio check"	
"Please repeat the message."	
"Please respond."	
The message is understood.	
The radio transmission is strong and clear.	
"I am ready to listen to you."	
"No"	
The conversation is finished.	
The radio transmission is finished.	
The message is received and understood.	
The message is acknowledged and placed on-hold.	

5. A level transmitter with tag number LT510D needs to be isolated and blown down. How would a control room operator describe the transmitter over the radio?

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### Chapter 3 (Cont.)

11. A plant employee whose job is to consider and organize all aspects of maintenance work is commonly called the \_\_\_\_\_.

#### Objective 4

12. What is an SOP?

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13. A new cooling tower has been installed in a power house. What should be considered when writing the SOP for placing the cooling tower in service?

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14. Who is best qualified to write an SOP for a particular pieces of equipment or process?

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15. What may be the consequence of using uncontrolled SOPs?

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#### Objective 5

16. Why do P&IDs need occasional revision?

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### Chapter 3 (Cont.)

17. What is “red-lining,” and why is it done?

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18. A printed P&ID should be compared to the \_\_\_\_\_ to make sure it shows all known changes.





## UNIT A-10 GLOSSARY

Term	Definition
<b>P&amp;ID</b>	See <i>pipng and instrumentation diagram</i> (P&ID).
<b>PFD</b>	See <i>process flow diagram</i> (PFD).
<b>Piping and instrumentation diagram (P&amp;ID)</b>	A piping and instrumentation diagram shows details of each major piece of equipment, the general piping orientation, the basic control and instrumentation devices and their orientation. It also shows some equipment sizing, but does not provide accurate plant dimensions.
<b>Process flow diagram (PFD)</b>	A process flow diagram is a simplified schematic of a plant or portion of the plant.
<b>Revision block</b>	The revision block in a plant diagram identifies all the revisions made to the diagram from when it was first issued.
<b>Title block</b>	In a plant diagram, the title block, usually in the lower right hand corner, provides all the information necessary to identify the diagram and verify its validity.

