Introduction to Blueprint Reading

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Fundamentals Handbook

ENGINEERING SYMBOLOGY, PRINTS, AND DRAWINGS
Module 1
Introduction to Print Reading

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TERMINAL OBJECTIVE

1.0 Given an engineering print, **READ** and **INTERPRET** the information contained in the title block, the notes and legend, the revision block, and the drawing grid.

ENABLING OBJECTIVES

1.1 **STATE** the five types of information provided in the title block of an engineering drawing.

1.2 **STATE** how the grid system on an engineering drawing is used to locate a piece of equipment.

1.3 **STATE** the three types of information provided in the revision block of an engineering drawing.

1.4 **STATE** the purpose of the notes and legend section of an engineering drawing.

1.5 **LIST** the five drawing categories used on engineering drawings.

INTRODUCTION TO PRINT READING

A through knowledge of the information presented in the title block, the revision block, the notes and legend, and the drawing grid is necessary before a drawing can be read. This information is displayed in the areas surrounding the graphic portion of the drawing.

EO 1.1 **STATE the five types of information provided in the title block of an engineering drawing.**

EO 1.2 **STATE how the grid system on an engineering drawing is used to locate a piece of equipment.**

EO 1.3 **STATE the three types of information provided in the revision block of an engineering drawing.**

EO 1.4 **STATE the purpose of the notes and legend section of an engineering drawing.**

Introduction

The ability to read and understand information contained on drawings is essential to perform most engineering-related jobs. Engineering drawings 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 drawing it is necessary to be familiar with the standard conventions, rules, and basic symbols used on the various types of drawings. But before learning how to read the actual "drawing," an understanding of the information contained in the various non-drawing areas of a print is also necessary. This chapter will address the information most commonly seen in the non-drawing areas of a nuclear grade engineering type drawing. Because of the extreme variation in format, location of information, and types of information presented on drawings from vendor to vendor and site to site, all drawings will not necessarily contain the following information or format, but will usually be similar in nature.

In this handbook the terms print, drawing, and diagram are used interchangeably to denote the complete drawing. This includes the graphic portion, the title block, the grid system, the revision block, and the notes and legend. When the words print, drawing, or diagram, appear in quotes, the word is referring only to the actual graphic portion of the drawing.

Anatomy of a Drawing

A generic engineering drawing can be divided into the following five major areas or parts.

1. Title block
2. Grid system
3. Revision block
4. Notes and legends
5. Engineering drawing (graphic portion)

The information contained in the drawing itself will be covered in subsequent modules. This module will cover the non-drawing portions of a print. The first four parts listed above provide important information about the actual drawing. The ability to understand the information contained in these areas is as important as being able to read the drawing itself. Failure to understand these areas can result in improper use or the misinterpretation of the drawing.

The Title Block

The title block of a drawing, usually located on the bottom or lower right hand corner, contains all the information necessary to identify the drawing and to verify its validity. A title block is divided into several areas as illustrated by Figure 1.

First Area of the Title Block

The first area of the title block contains the drawing title, the drawing number, and lists the location, the site, or the vendor. The drawing title and the drawing number are used for identification and filing purposes. Usually the number is unique to the drawing and is comprised of a code that contains information about the drawing such as the site, system, and type of drawing. The drawing number may also contain information such as the sheet number, if the drawing is part of a series, or it may contain the revision level. Drawings are usually filed by their drawing number because the drawing title may be common to several prints or series of prints.

Second Area of the Title Block

The second area of the title block contains the signatures and approval dates, which provide information as to when and by whom the component/system was designed and when and by whom the drawing was drafted and verified for final approval. This information can be invaluable in locating further data on the system/component design or operation. These names can also help in the resolution of a discrepancy between the drawing and another source of information.

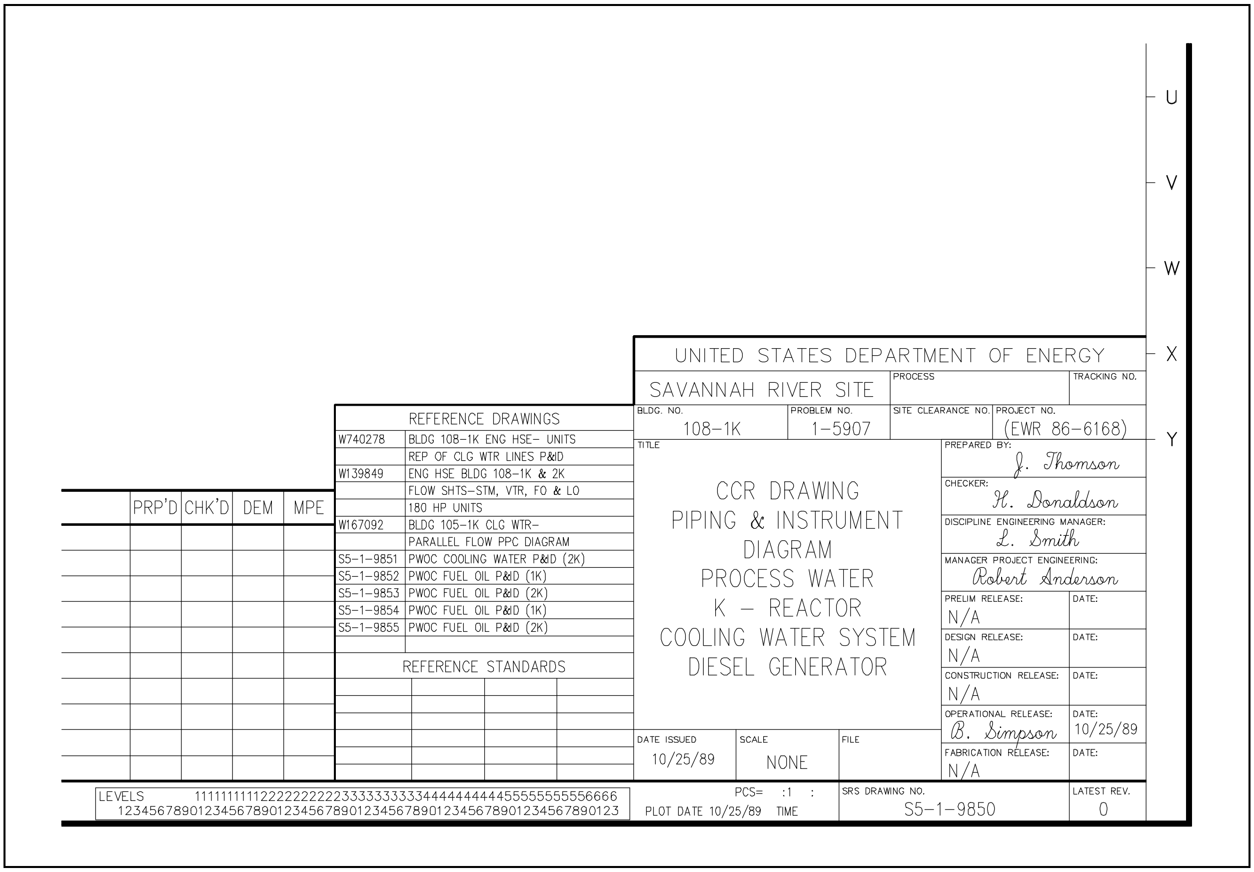

Figure 1 Title Block

Third Area of the Title Block

The third area of the title block is the reference block. The reference block lists other drawings that are related to the system/component, or it can list all the other drawings that are cross-referenced on the drawing, depending on the site's or vendor's conventions. The reference block can be extremely helpful in tracing down additional information on the system or component.

Other information may also be contained in the title block and will vary from site to site and vendor to vendor. Some examples are contract numbers and drawing scale.

Drawing Scale

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

Scale drawings usually present the information used to fabricate or construct a component or system. If a drawing is drawn to scale, it can be used to obtain information such as physical dimensions, tolerances, and materials that allows the fabrication or construction of the component or system. Every dimension of a component or system does not have to be stated in writing on the drawing because the user can actually measure the distance (e.g., the length of a part) from the drawing and divide or multiply by the stated scale to obtain the correct measurements.

The scale of a drawing is usually presented as a ratio and is read as illustrated in the following examples.

1" = 1" Read as 1 inch (on the drawing) equals 1 inch (on the actual component or system). This can also be stated as FULL SIZE in the scale block of the drawing. The measured distance on the drawing is the actual distance or size of the component.

3/8" = 1' Read as 3/8 inch (on the drawing) equals 1 foot (on the actual component or system). This is called 3/8 scale. For example, if a component part measures 6/8 inch on the drawing, the actual component measures 2 feet.

1/2" = 1' Read as 1/2 inch (on the drawing) equals 1 foot (on the actual component or system). This is called 1/2 scale. For example, if a component part measures 1-1/2 inches on the drawing the actual component measures 3 feet.

Grid System

Because drawings tend to be large and complex, finding a specific point or piece of equipment on a drawing can be quite difficult. This is especially true when one wire or pipe run is continued on a second drawing. To help locate a specific point on a referenced print, most drawings, especially Piping and Instrument Drawings (P&ID) and electrical schematic drawings, have a grid system. The grid can consist of letters, numbers, or both that run horizontally and vertically around the drawing as illustrated on Figure 2. Like a city map, the drawing is divided into smaller blocks, each having a unique two letter or number identifier. For example, when a pipe is continued from one drawing to another, not only is the second drawing referenced on the first drawing, but so are the grid coordinates locating the continued pipe. Therefore the search for the pipe contained in the block is much easier than searching the whole drawing.

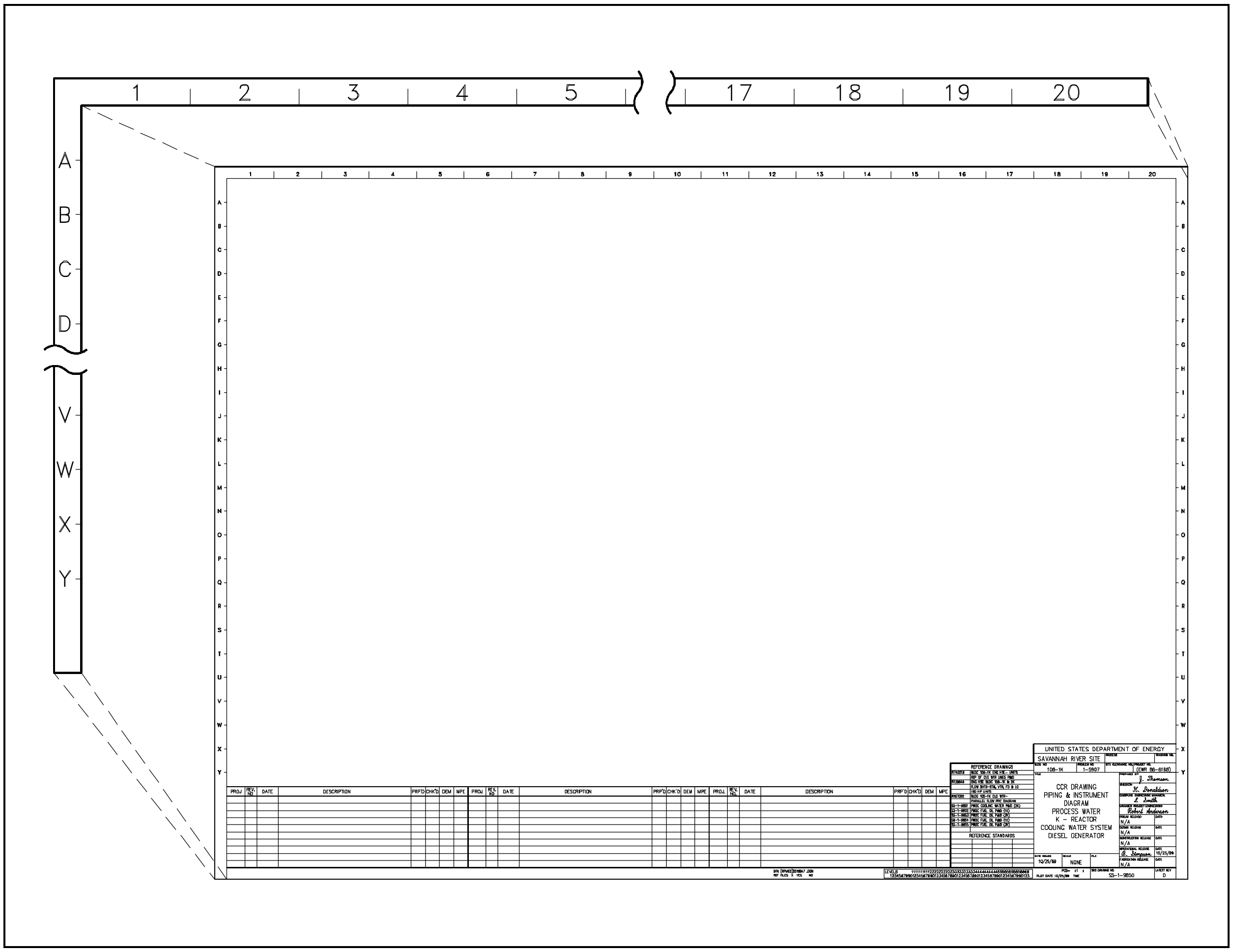

Figure 2 Example of a Grid

Revision Block

As changes to a component or system are made, the drawings depicting the component or system must be redrafted and reissued. When a drawing is first issued, it is called revision zero, and the revision block is empty. As each revision is made to the drawing, an entry is placed in the revision block. This entry will provide the revision number, a title or summary of the revision, and the date of the revision. The revision number may also appear at the end of the drawing number or in its own separate block, as shown in Figure 2, Figure 3. As the component or system is modified, and the drawing is updated to reflect the changes, the revision number is increased by one, and the revision number in the revision block is changed to indicate the new revision number. For example, if a Revision 2 drawing is modified, the new drawing showing the latest modifications will have the same drawing number, but its revision level will be increased to 3. The old Revision 2 drawing will be filed and maintained in the filing system for historical purposes.

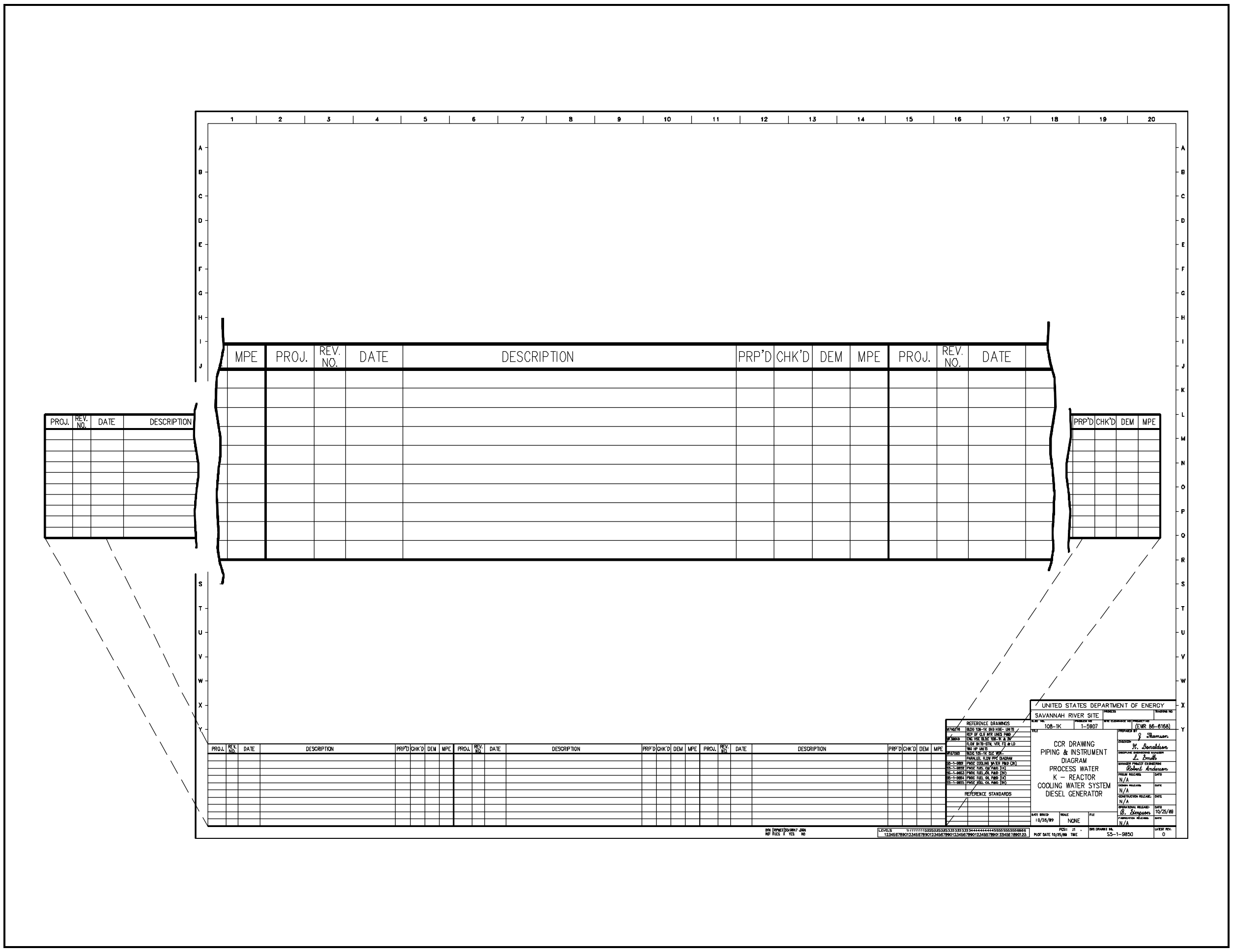

Figure 3 Revision Block

Changes

There are two common methods of indicating where a revision has changed a drawing that contains a system diagram. The first is the cloud method, where each change is enclosed by a hand-drawn cloud shape, as shown in Figure 4. The second method involves placing a circle (or triangle or other shape) with the revision number next to each effected portion of the drawing, as shown in Figure 4. The cloud method indicates changes from the most recent revision only, whereas the second method indicates all revisions to the drawing because all of the previous revision circles remain on the drawing.

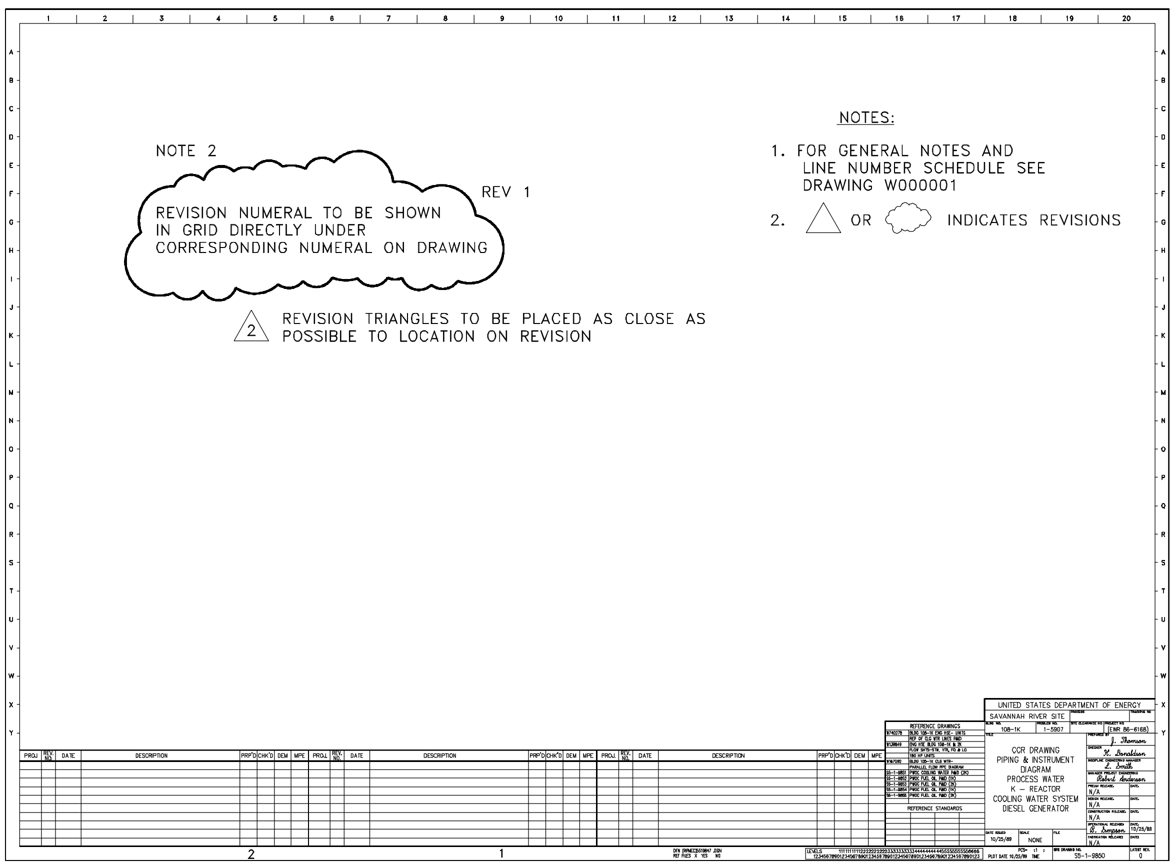

Figure 4 Methods of Denoting Changes

The revision number and revision block are especially useful in researching the evolution of a specific system or component through the comparison of the various revisions.

Notes and Legend

Drawings are comprised of symbols and lines that represent components or systems. Although a majority of the symbols and lines are self-explanatory or standard (as described in later modules), a few unique symbols and conventions must be explained for each drawing. The notes and legends section of a drawing lists and explains any special symbols and conventions used on the drawing, as illustrated on Figure 5. Also listed in the notes section is any information the designer or draftsman felt was necessary to correctly use or understand the drawing. Because of the importance of understanding all of the symbols and conventions used on a drawing, the notes and legend section must be reviewed before reading a drawing.

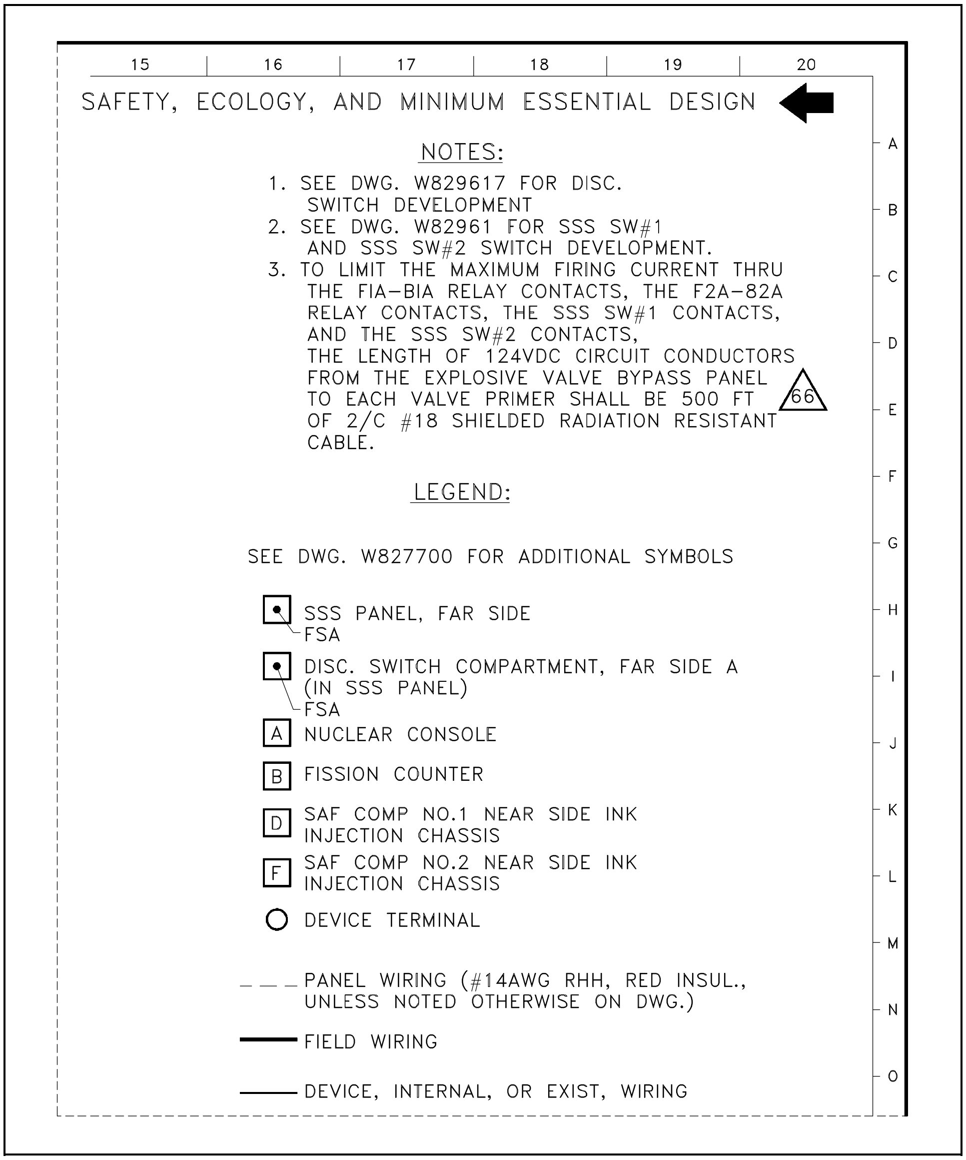

Figure 5 Notes and Legends

Summary

The important information in this chapter is summarized below.

Introduction to Print Reading Summary

- The title block of a drawing contains:

  the drawing title
  the drawing number
  location, site, or vendor issuing the drawing
  the design, review, and approval signatures
  the reference block

- The grid system of a drawing allows information to be more easily identified using the coordinates provided by the grid. The coordinate letters and/or numbers break down the drawing into smaller blocks.

- The revision block of a drawing provides the revision number, a title or summary of the revision, and the date of the revision, for each revision.

- The notes and legend section of a drawing provides explanations of special symbols or conventions used on the drawing and any additional information the designer or draftsman felt was necessary to understand the drawing.

INTRODUCTION TO THE TYPES OF DRAWINGS, VIEWS, AND PERSPECTIVES

To read a drawing correctly, the user must have a basic understanding of the various categories of drawings and the views and perspectives in which each drawing can be presented.

EO 1.5 LIST the five drawing categories used on engineering drawings.

Categories of Drawings

The previous chapter reviewed the non-drawing portions of a print. This chapter will introduce the five common categories of drawings. They are 1) piping and instrument drawings (P&IDs), 2) electrical single lines and schematics, 3) electronic diagrams and schematics, 4) logic diagrams and prints, and 5) fabrication, construction, and architectural drawings.

Piping and Instrument Drawings (P&IDs)

P&IDs are usually designed to present functional information about a system or component. Examples are piping layout, flowpaths, pumps, valves, instruments, signal modifiers, and controllers, as illustrated in Figure 6.

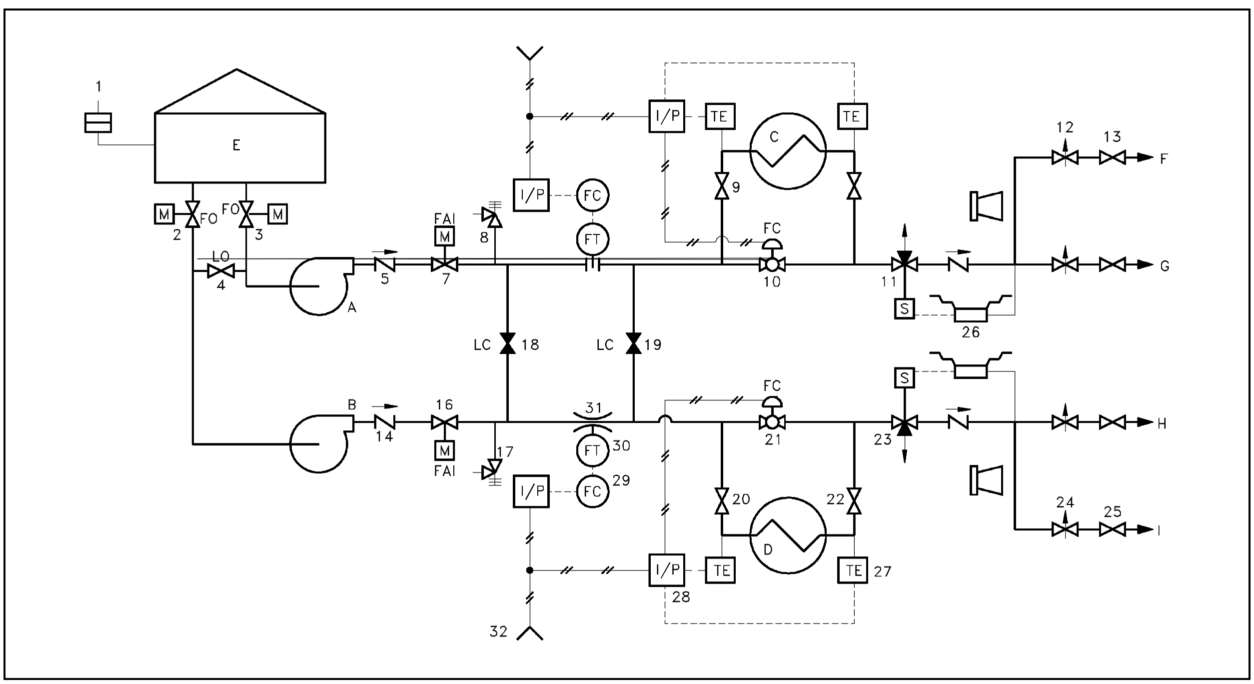

Figure 6 Example P&ID

As a rule P&IDs do not have a drawing scale and present only the relationship or sequence between components. Just because two pieces of equipment are drawn next to each other does not indicate that in the plant the equipment is even in the same building; it is just the next part or piece of the system. These drawings only present information on how a system functions, not the actual physical relationships.

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.

Electrical Single Lines and Schematics

Electrical single lines and schematics are designed to present functional information about the electrical design of a system or component. They provide the same types of information about electrical systems that P&IDs provide for piping and instrument systems. Like P&IDs, electrical prints are not usually drawn to scale. Examples of typical single lines are site or building power distribution, system power distribution, and motor control centers. Figure 7 is an example of an electrical single line.

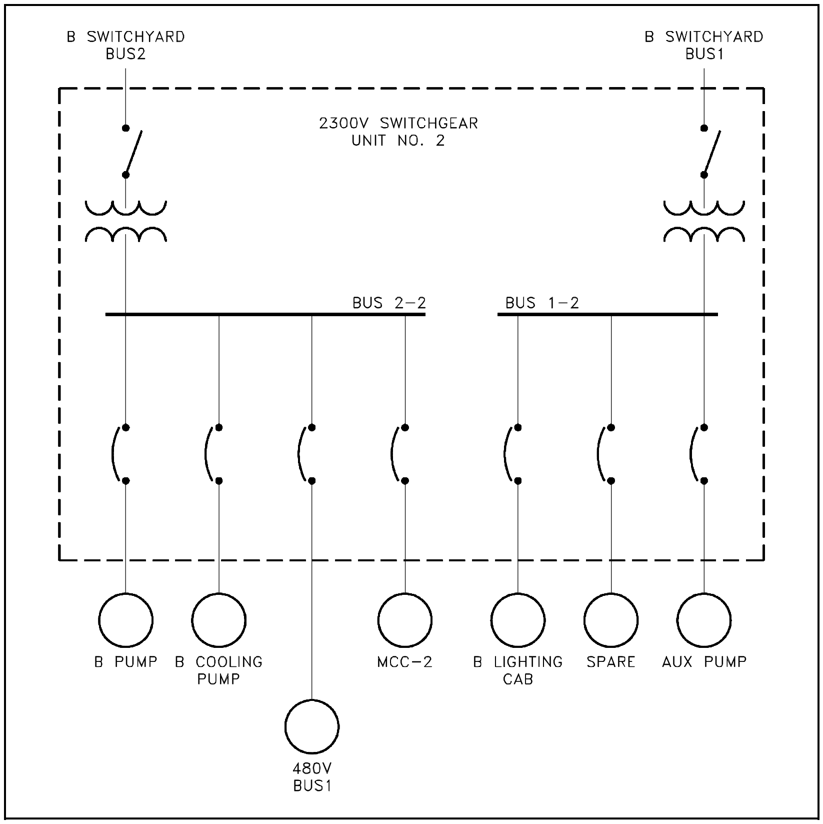

Figure 7 Example of a Single Line

Electrical schematics provide a more detailed level of information about an electrical system or component than the single lines. Electrical schematic drawings present information such as the individual relays, relay contacts, fuses, motors, lights, and instrument sensors. Examples of typical schematics are valve actuating circuits, motor start circuits, and breaker circuits.

Figure 8 is an example of a motor start circuit schematic. Electrical single lines and schematics provide the most concise format for depicting how electrical systems should function, and are used extensively in the operation, repair, and modification of the plant.

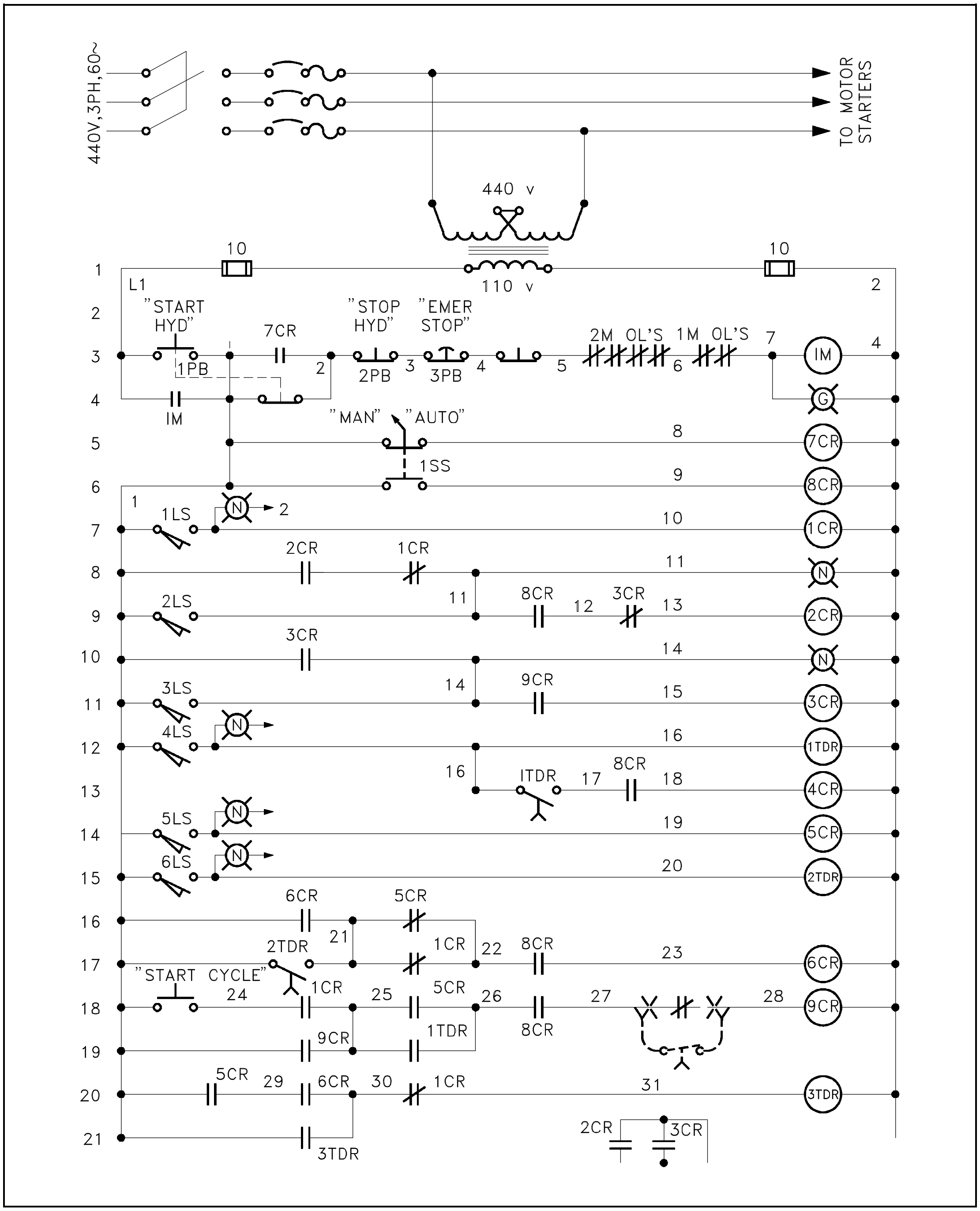

Figure 8 Example of a Schematic

Electronic Diagrams and Schematics

Electronic diagrams and schematics are designed to present information about the individual components (resistors, transistors, and capacitors) used in a circuit, as illustrated in Figure 9. These drawings are usually used by circuit designers and electronics repair personnel.

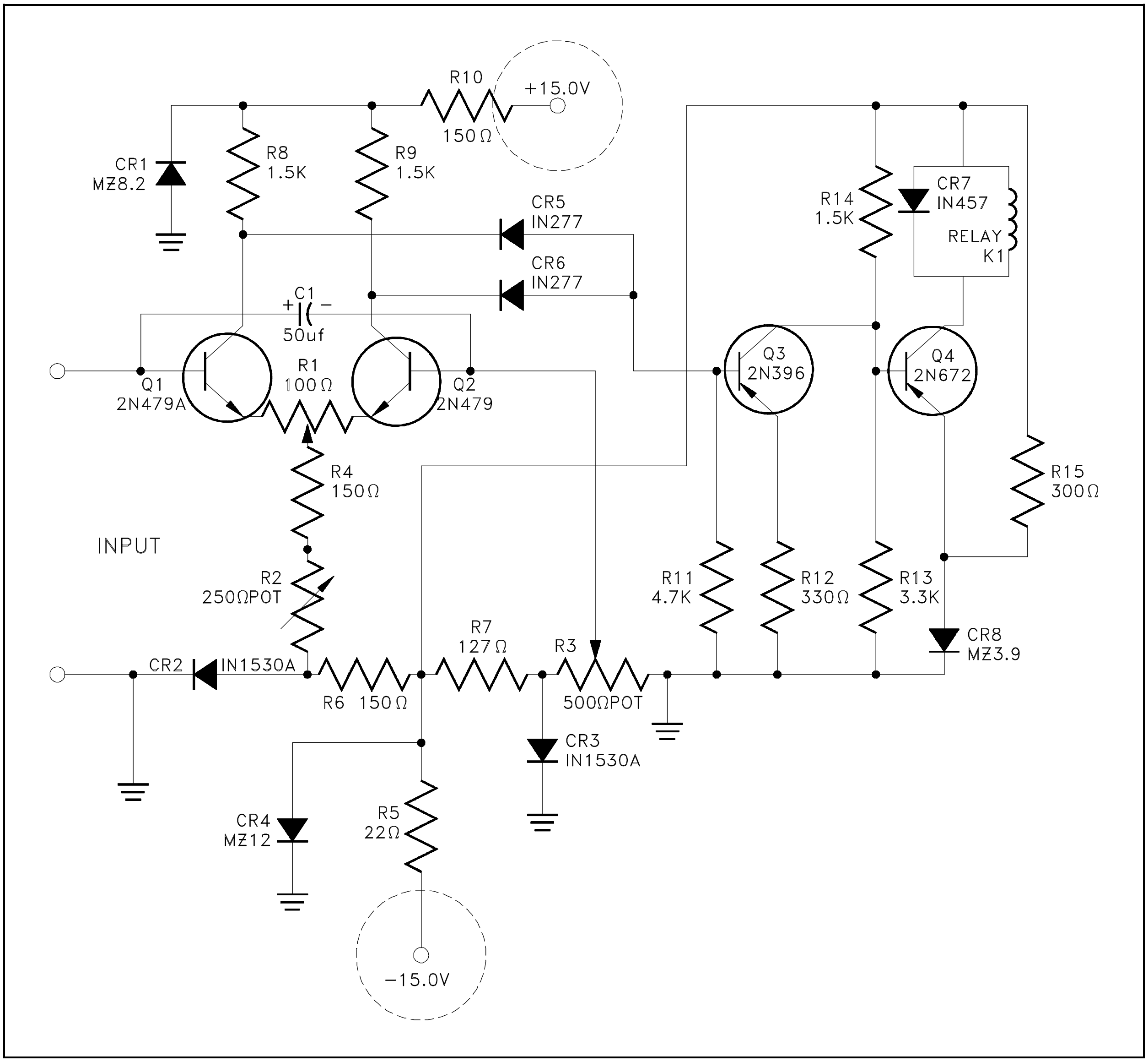

Figure 9 Example of an Electronic Diagram

Logic Diagrams and Prints

Logic diagrams and prints can be used to depict several types of information. The most common use is to provide a simplified functional representation of an electrical circuit, as illustrated in Figure 10. For example, it is easier and faster to figure out how a valve functions and responds to various inputs signals by representing a valve circuit using logic symbols, than by using the electrical schematic with its complex relays and contacts. These drawings do not replace schematics, but they are easier to use for certain applications.

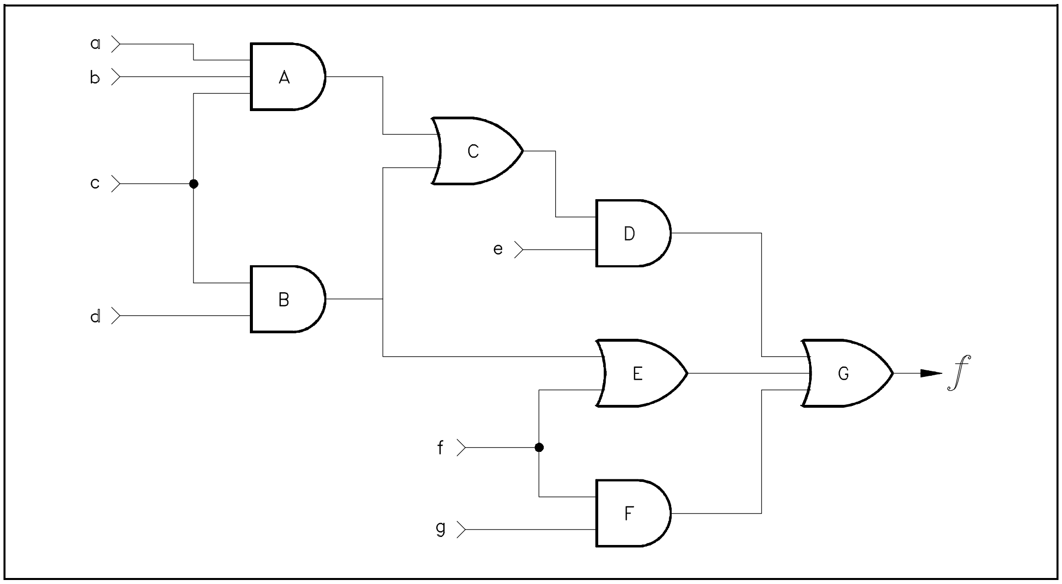

Figure 10 Example of a Logic Print

Fabrication, Construction, and Architectural Drawings

Fabrication, construction, and architectural drawings are designed to present the detailed information required to construct or fabricate a part, system, or structure. These three types of drawings differ only in their application as opposed to any real differences in the drawings themselves. Construction drawings, commonly referred to as "blueprint" drawings, present the detailed information required to assemble a structure on site. Architectural drawings present information about the conceptual design of the building or structure. Examples are house plans, building elevations (outside view of each side of a structure), equipment installation drawings, foundation drawings, and equipment assembly drawings.

Fabrication drawings, as shown in Figure 11, are similar to construction and architectural drawing but are usually found in machine shops and provide the necessary detailed information for a craftsman to fabricate a part. All three types of drawings, fabrication, construction, and architectural, are usually drawn to scale.

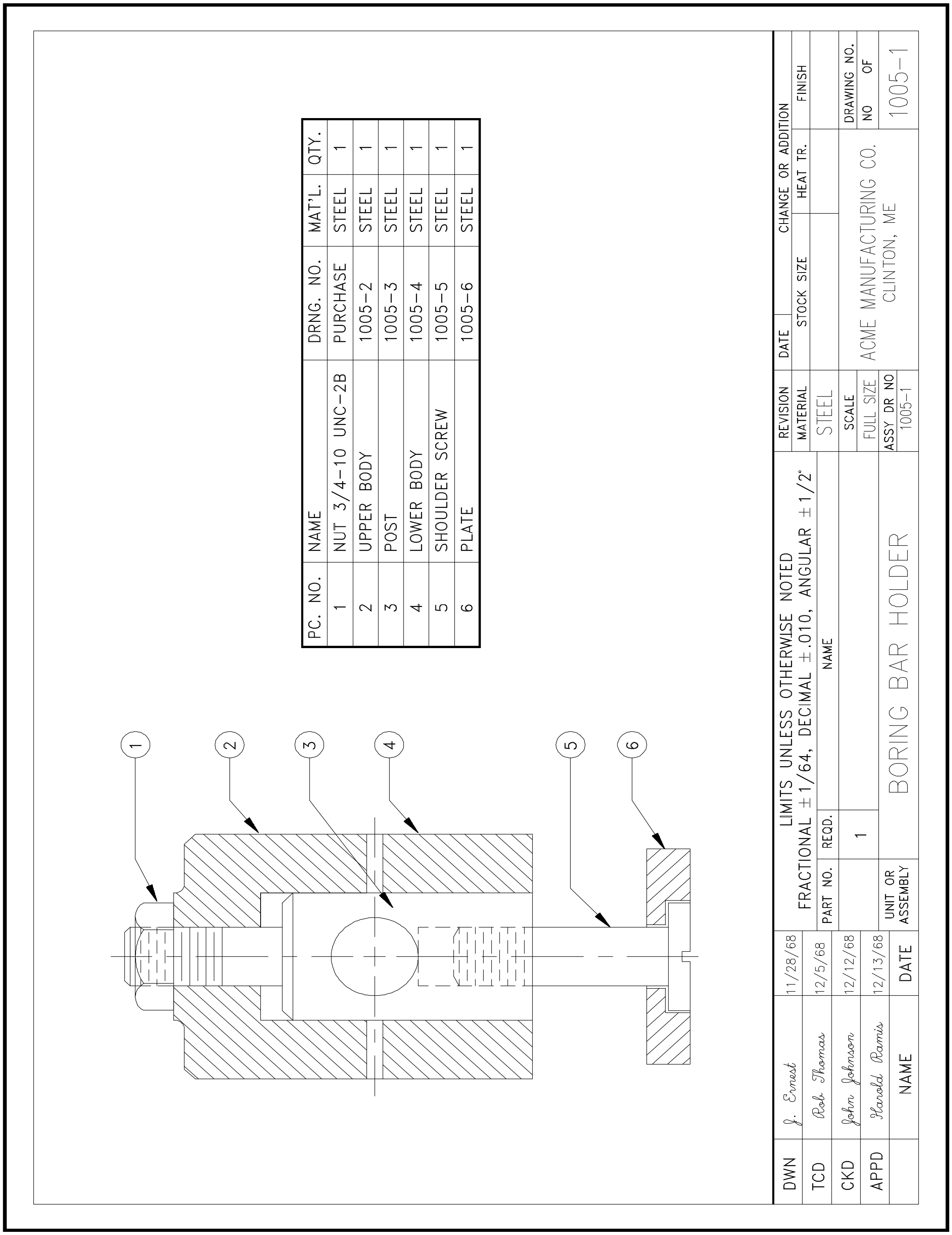

Figure 11 Example of a Fabrication Drawing

Drawing Format

P&IDs, fabrication, construction, and architectural drawings can be presented using one of several different formats. The standard formats are single line, pictorial or double line, and cutaway. Each format provides specific information about a component or system.

Single Line Drawings

The single line format is most commonly used in P&IDs. Figure 12 is an example of a single line P&ID. The single line format represents all piping, regardless of size, as single line. All system equipment is represented by simple standard symbols (covered in later modules). By simplifying piping and equipment, single lines allow the system's equipment and instrumentation relationships to be clearly understood by the reader.

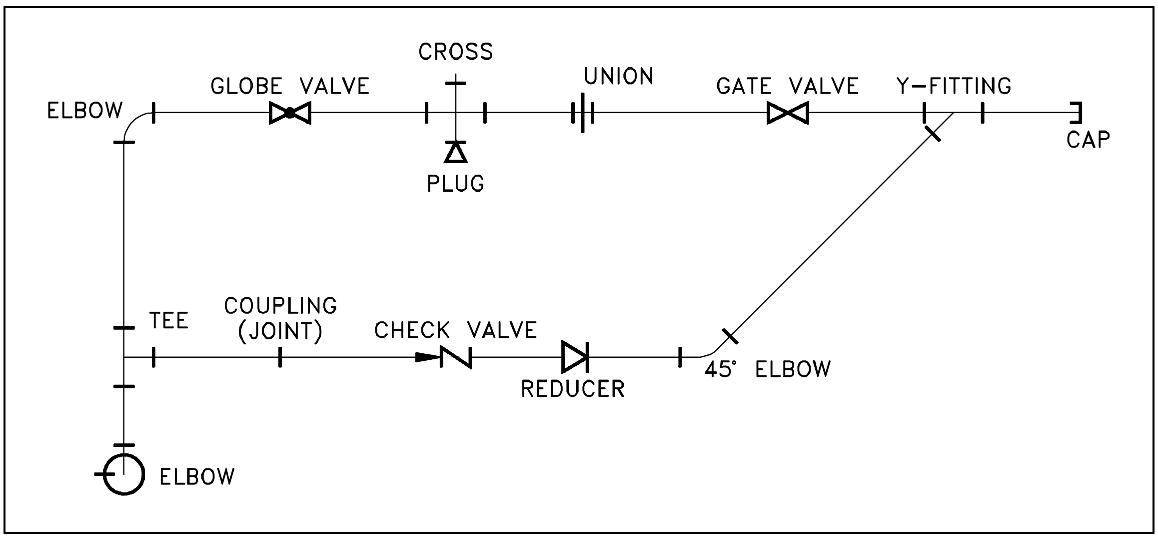

Figure 12 Example of a Single Line P&ID

Pictorial or Double Line Drawings

Pictorial or double line drawings present the same type information as a single line, but the equipment is represented as if it had been photographed. Figure 13 provides an example illustration of a pictorial drawing. This format is rarely used since it requires much more effort to produce than a single line drawing and does not present any more information as to how the system functions. Compare the pictorial illustration, Figure 13, to the single line of the same system shown in Figure 12. Pictorial or double line drawings are often used in advertising and training material.

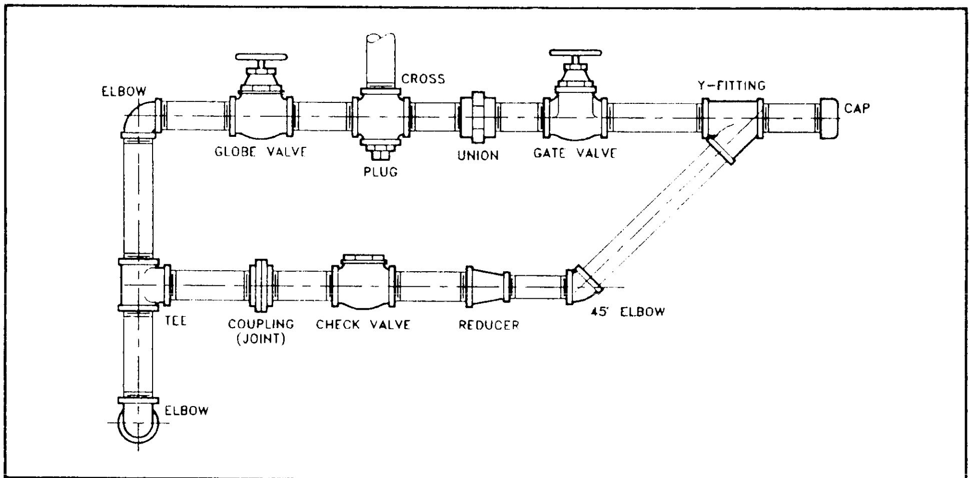

Figure 13 Example Pictorial

Assembly Drawings

Assembly drawing are a special application of pictorial drawings that are common in the engineering field. As seen in Figure 14, an assembly drawing is a pictorial view of the object with all the components shown as they go together. This type pictorial is usually found in vendor manuals and is used for parts identification and general information relative to the assembly of the component.

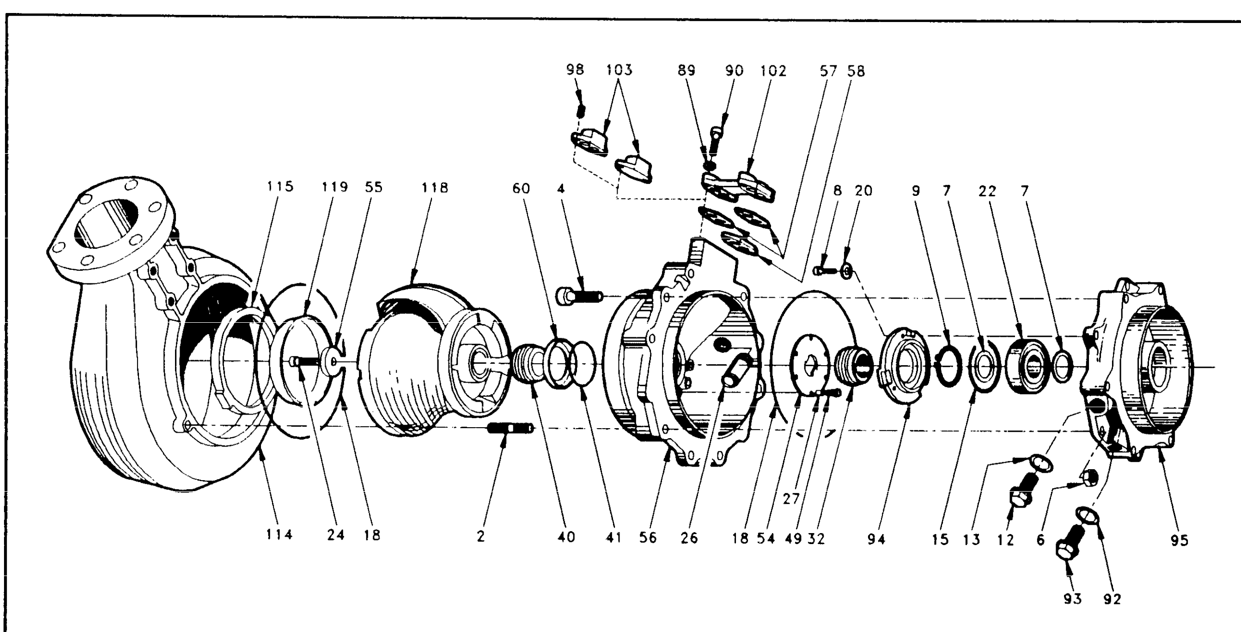

Figure 14 Example of an Assembly Drawing

Cutaway Drawings

A cutaway drawing is another special type of pictorial drawing. In a cutaway, as the name implies, the component or system has a portion cut away to reveal the internal parts of the component or system. Figure 15 is an illustration of a cutaway. This type of drawing is extremely helpful in the maintenance and training areas where the way internal parts are assembled is important.

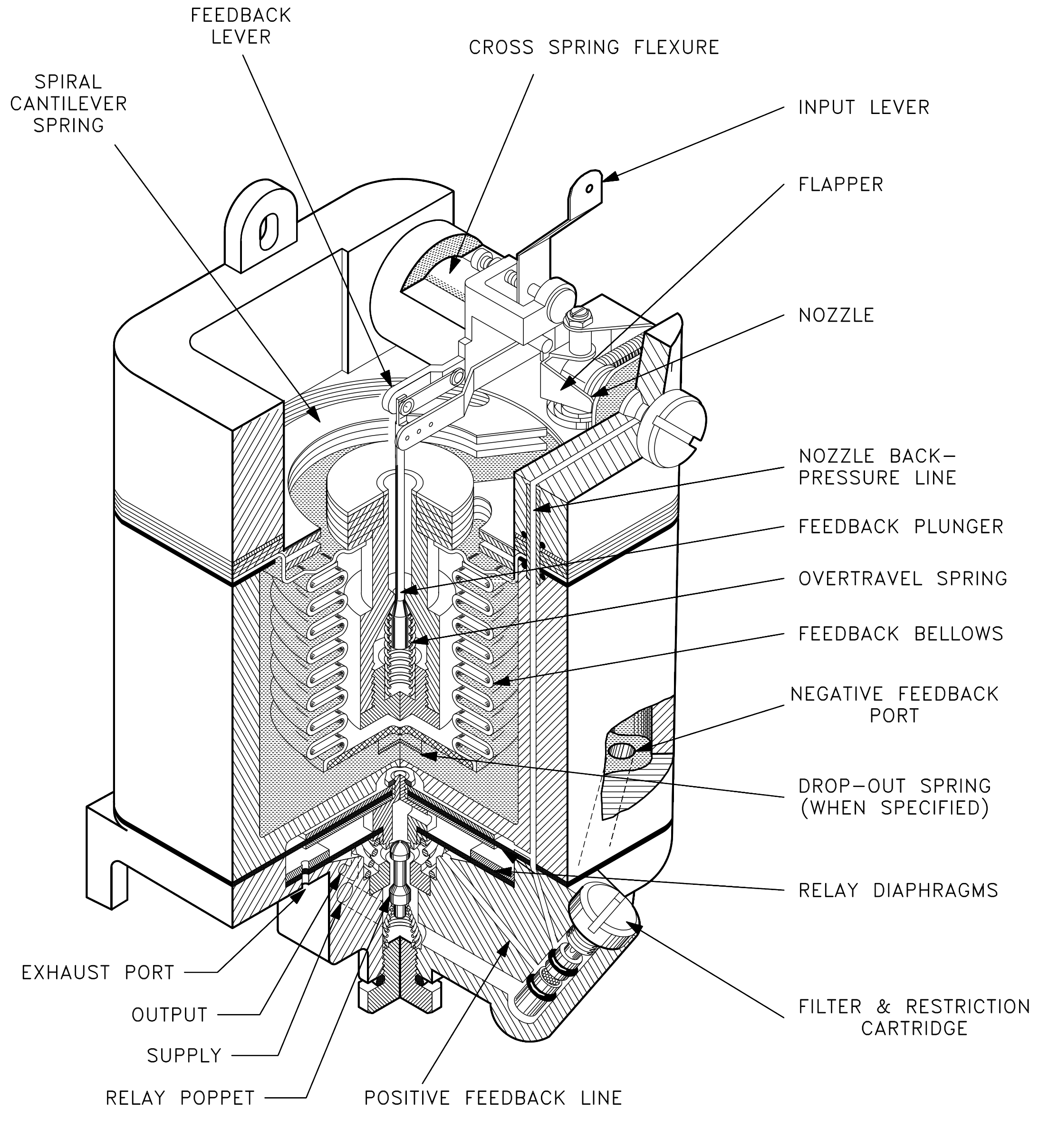

Figure 15 Example of a Cutaway

Views and Perspectives

In addition to the different drawing formats, there are different views or perspectives in which the formats can be drawn. The most commonly used are the orthographic projection and the isometric projection.

Orthographic Projections

Orthographic projection is widely used for fabrication and construction type drawings, as shown in Figure 16. Orthographic projections present the component or system through the use of three views, These are a top view, a side view, and a front view. Other views, such as a bottom view, are used to more fully depict the component or system when necessary.

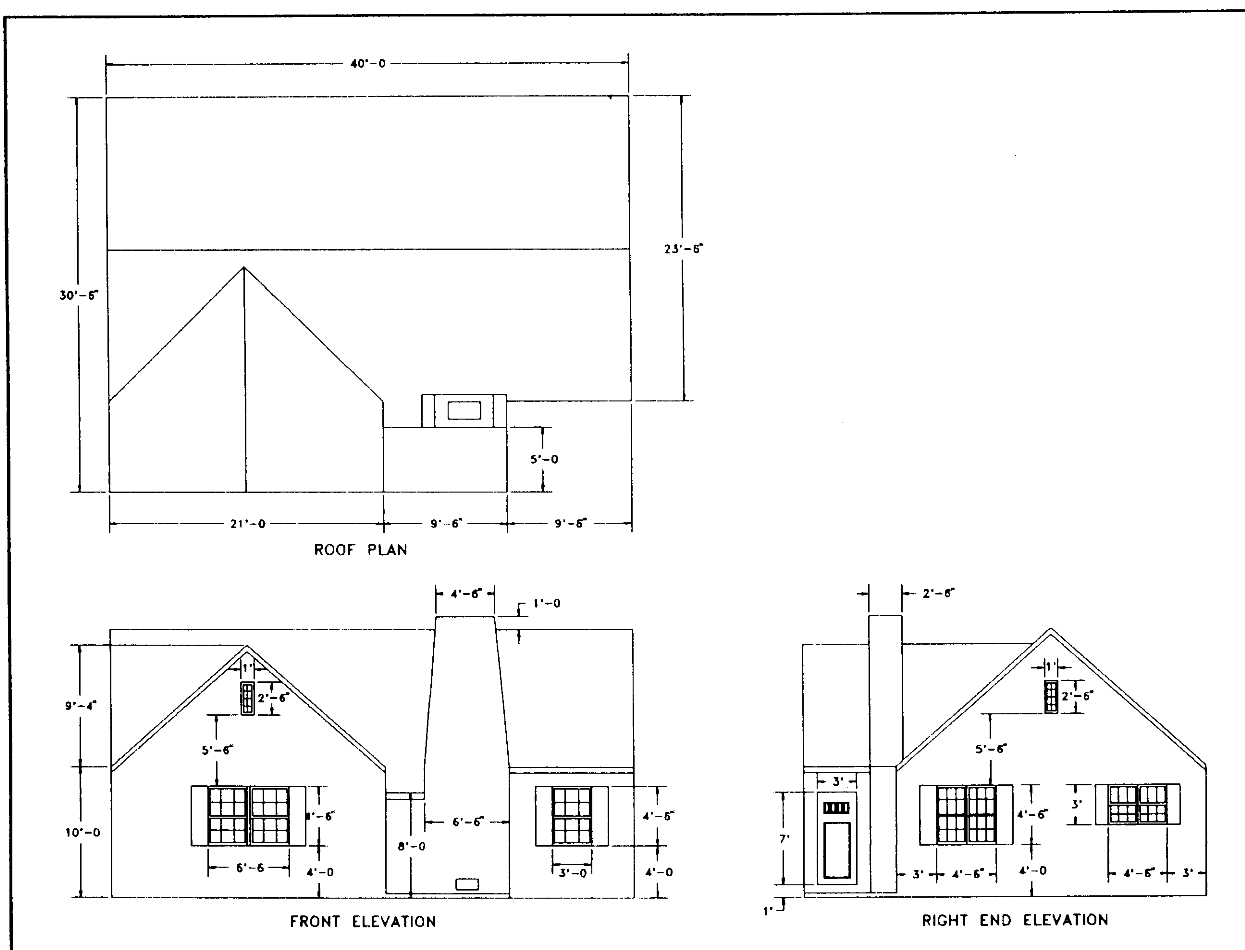

Figure 16 Example Orthographic Projection

Figure 17 shows how each of the three views is obtained. The orthographic projection is typically drawn to scale and shows all components in their proper relationships to each other. The three views, when provided with dimensions and a drawing scale, contain information that is necessary to fabricate or construct the component or system.

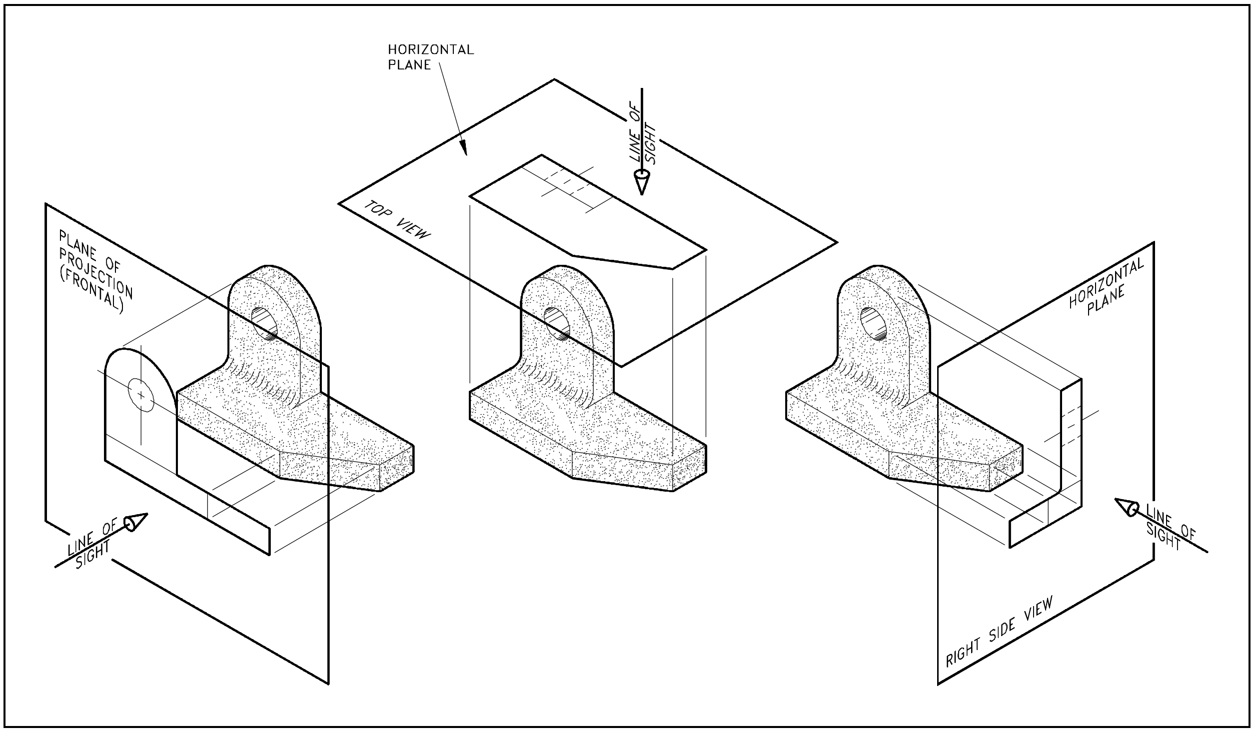

Figure 17 Orthographic Projections

Isometric Projection

The isometric projection presents a single view of the component or system. The view is commonly from above and at an angle of 30°. This provides a more realistic three-dimensional view. As shown on Figure 18, this view makes it easier to see how the system looks and how its various portions or parts are related to one another. Isometric projections may or may not be drawn to a scale.

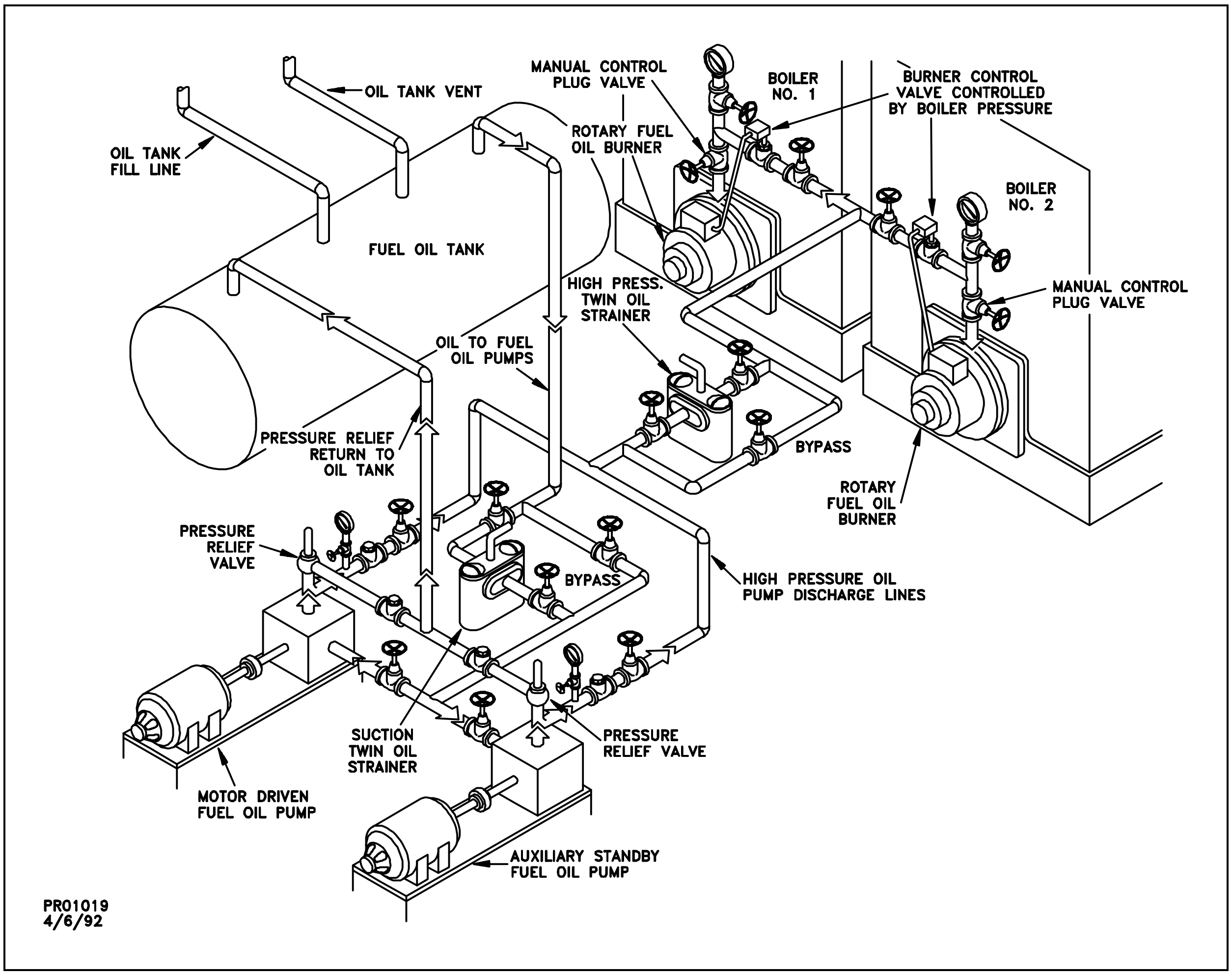

Figure 18 Example of an Isometric

Summary

The important information in this chapter is summarized below.

Drawing Types, Views, and Perspectives Summary

- The five engineering drawing categories are:

  P&IDs

  Electrical single lines and schematics

  Electronic diagrams and schematics

  Logic diagrams and prints

  Fabrication, construction, and architectural drawings