

PROCESS CONTROL SYSTEMS

3

**LEARNING
ACTIVITY
PACKET**

PIPING AND INSTRUMENTATION DIAGRAMS



B270-XD

PIPING AND INSTRUMENTATION DIAGRAMS

INTRODUCTION

Piping and instrumentation diagrams (P&IDs) provide a visual representation of the overall function of a process as well as specific information. This information can include the type of signal being sent to a device (e.g. pneumatic, electrical) and the types of control and sensing elements in the process.

This LAP covers the symbols for sensors and control elements, as well as the line symbols used in P&IDs. It also covers the instrument index, which is a valuable tool used to help operators and technicians organize the many process documents.

ITEMS NEEDED



Amatrol Supplied

- 1 T5552 Process Control Learning System

School Supplied

- 1 Water Supply
- 1 Compressed Air Supply

FIRST EDITION, LAP 3, REV. A

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SEGMENT 1

LINE SYMBOLS

OBJECTIVE 1

DESCRIBE THE FUNCTION OF A P&ID



Piping and Instrumentation Diagrams (P&ID), like the one in figure 1, are drawings that show the layout of an entire process or a section of a process. P&IDs (also called flow diagrams) include things such as:

- Process flow
- Major components within the system
- Different types of signals within the process
- Interconnection between components

P&IDs do not, however, show the physical location of devices, the spatial distance between devices or the size of each device. In addition, not all components within the system will appear on a P&ID. Only the major components affecting the process are shown.

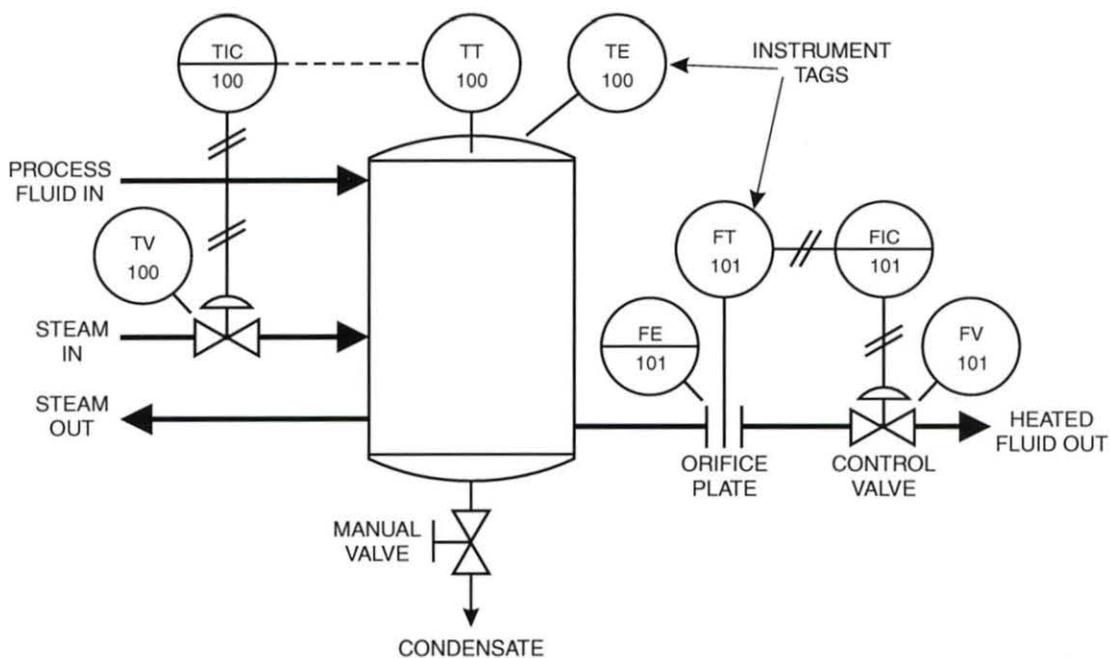


Figure 1. Flow Diagram (P&ID)

OBJECTIVE 2

DESCRIBE THE FUNCTION OF A LOOP DIAGRAM



P&IDs often consist of several control loops. Typically, P&IDs are broken into smaller diagrams which show each loop of the process individually. These individual diagrams are called loop diagrams or loop sheets. Loop diagrams are often helpful when performing set up, calibration, and troubleshooting.

Figure 2 shows an example of a loop diagram. In this example, loop 401 controls the flow of the process fluid.

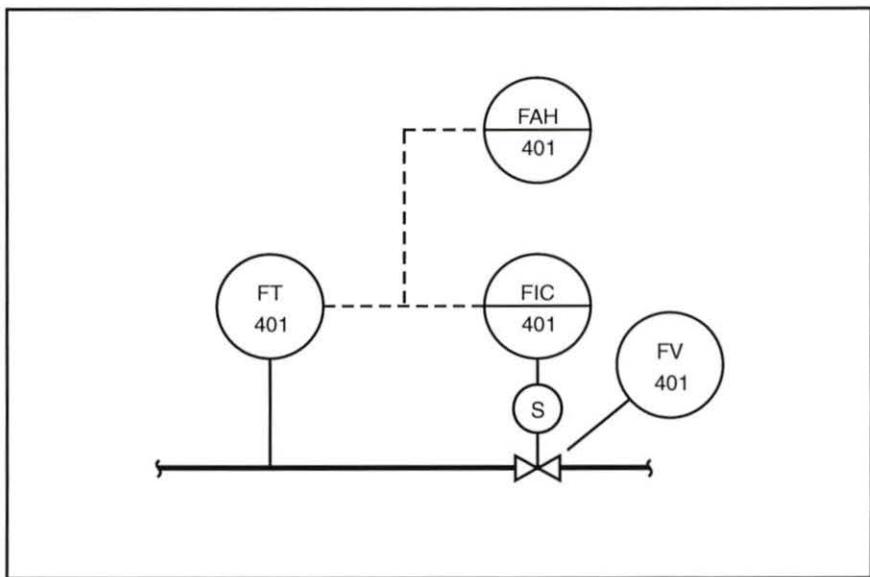


Figure 2. Loop Diagram



The line symbols used in P&IDs identify process piping, connections to the process, and the method used to transfer signals from instrument to instrument within the loop. P&IDs differentiate between the various lines because one diagram typically includes multiple types of signals.

Ten common line symbols used on P&IDs are displayed in figure 3.

	PROCESS PIPING
	PROCESS CONNECTION
	PNEUMATIC LINE
	ELECTRIC LINE
	HYDRAULIC LINE
	CAPILLARY TUBE
	ULTRASONIC WAVES (GUIDED)
	ULTRASONIC WAVES (UNGUIDED)
	INTERNAL SYSTEM LINK
	MECHANICAL LINK

Figure 3. P&ID Line Symbols

Process Piping

The first type of line symbol is a bold dark line that represents the main process piping. The process piping is the main flow line that carries the process materials (i.e. fluids, chemicals, etc).

Process Connection

A solid line that is not bold tells you that the line is a process connection. A process connection line is any line that taps into the main process piping. An instrument line that connects to the process piping to monitor the status of the material in the process piping is an example of a process connection.

Pneumatic Line

Pneumatic signals are frequently used to control a process. The symbol for a line that carries a compressed gas is a solid line with two slashes through it.

Electrical Line

An electric line appears as either a line with three slashes through it or, more commonly, as a dashed line from device to device.

Hydraulic Line

A hydraulic line appears as a line with a series of L's drawn through it.

Capillary Tubes

Capillary tubes are small diameter tubes that are used for signal transmission. An example of a capillary tube is the copper tubing connected to an alcohol-filled thermometer. The symbol for a capillary tube is a fine line with a series of X's through it.

Ultrasonic Waves (Guided)

The use of ultrasonic waves in instrumentation is becoming more common. Ultrasonic waves are high frequency waves that we cannot see or hear. Typically, these waves are used in one of two fashions: guided and unguided.

Guided waves are transmitted through a device called a waveguide, which is typically a metal container. The line symbol for a guided wave is a line with sine waves drawn on it.

Ultrasonic Waves (Unguided)

Unguided ultrasonic waves are transmitted through the air. The line symbol for an unguided ultrasonic wave is sine waves without the line in the middle.

Internal System Link

Many modern processes use computer software to replace field devices. If software emulates a device, the connections to the other devices in the loop are shown with the internal system link symbol, which is a line with open circles.

Mechanical Link

The mechanical system link symbol is used when a signal is transmitted by a mechanical connection. It consists of a line and circles with a dot inside each circle.

OBJECTIVE 4 DESCRIBE HOW TO REPRESENT BINARY SIGNALS IN A P&ID



To aid in the identification of the nature of line symbols, backslashes are sometimes added to denote that the signal being transmitted is binary, as shown in figure 4. If a device is considered binary, it has only two operating conditions: On (1) or Off (0).

If a device is understood to be binary, such as the case with a solenoid valve, then you may want to put backslashes through its line symbol. However, it is not mandatory.

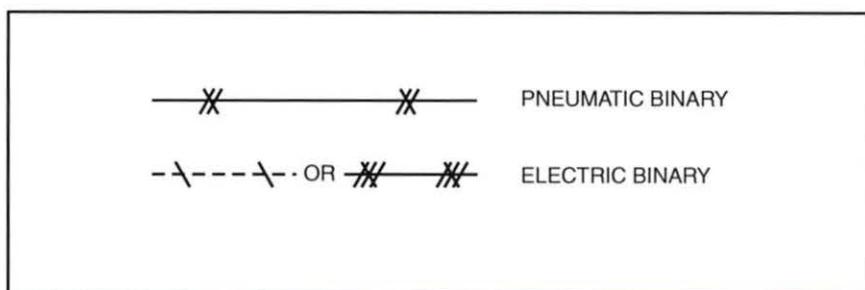


Figure 4. Binary Line Symbols

Procedure Overview

In this procedure, you will identify line symbols used to represent various types of process connections on a P&ID so that you can increase your ability to read P&IDs.



1. Identify the line symbol shown in figure 5.

Line Symbol _____



Figure 5. Line Symbol

You should find that the symbol indicates a pneumatic binary line because the symbol shows a horizontal line with double forward slashes and a superimposed backslash along the line.

2. Identify the line symbol shown in figure 6.

Line Symbol _____



Figure 6. Line Symbol

You should find that the symbol indicates a hydraulic line because the symbol shows a horizontal line with an L through it.

3. Identify the line symbol shown in figure 7.

Line Symbol _____



Figure 7. Line Symbol

You should find that the symbol indicates guided ultrasonic waves because the symbol shows a horizontal line with a sinusoidal wave along it.

4. Identify the line symbol shown in figure 8.

Line Symbol _____

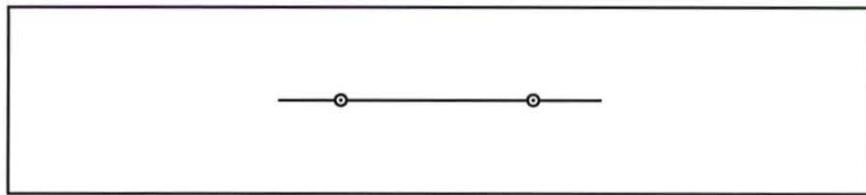


Figure 8. Line Symbol

You should find that the symbol indicates a mechanical link because the symbol shows a horizontal line with a small circle that has a dot in the center along it.

5. Identify the line symbol shown in figure 9.

Line Symbol _____

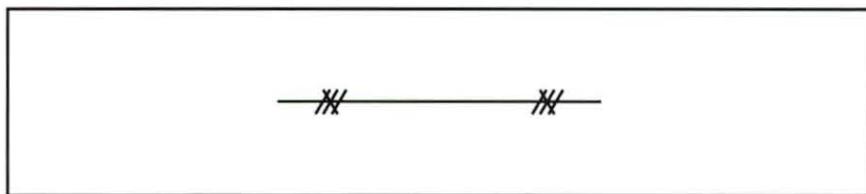


Figure 9. Line Symbol

You should find that the symbol indicates a binary electrical line because the symbol shows a horizontal line with three forward slashes and a superimposed backslash along it.

6. Identify the line symbol shown in figure 10.

Line Symbol _____

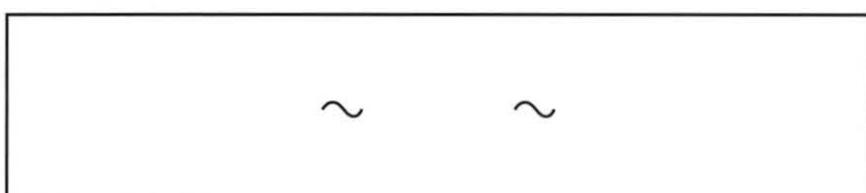


Figure 10. Line Symbol

You should find that the symbol indicates unguided ultrasonic waves because the symbol shows sinusoidal waves that are not along a line.

7. Identify the line symbol shown in figure 11.

Line Symbol _____



Figure 11. Line Symbol

You should find that the symbol indicates an electrical binary line because the symbol shows a dashed horizontal line with a backslash.

8. Identify the line symbol that each letter indicates.

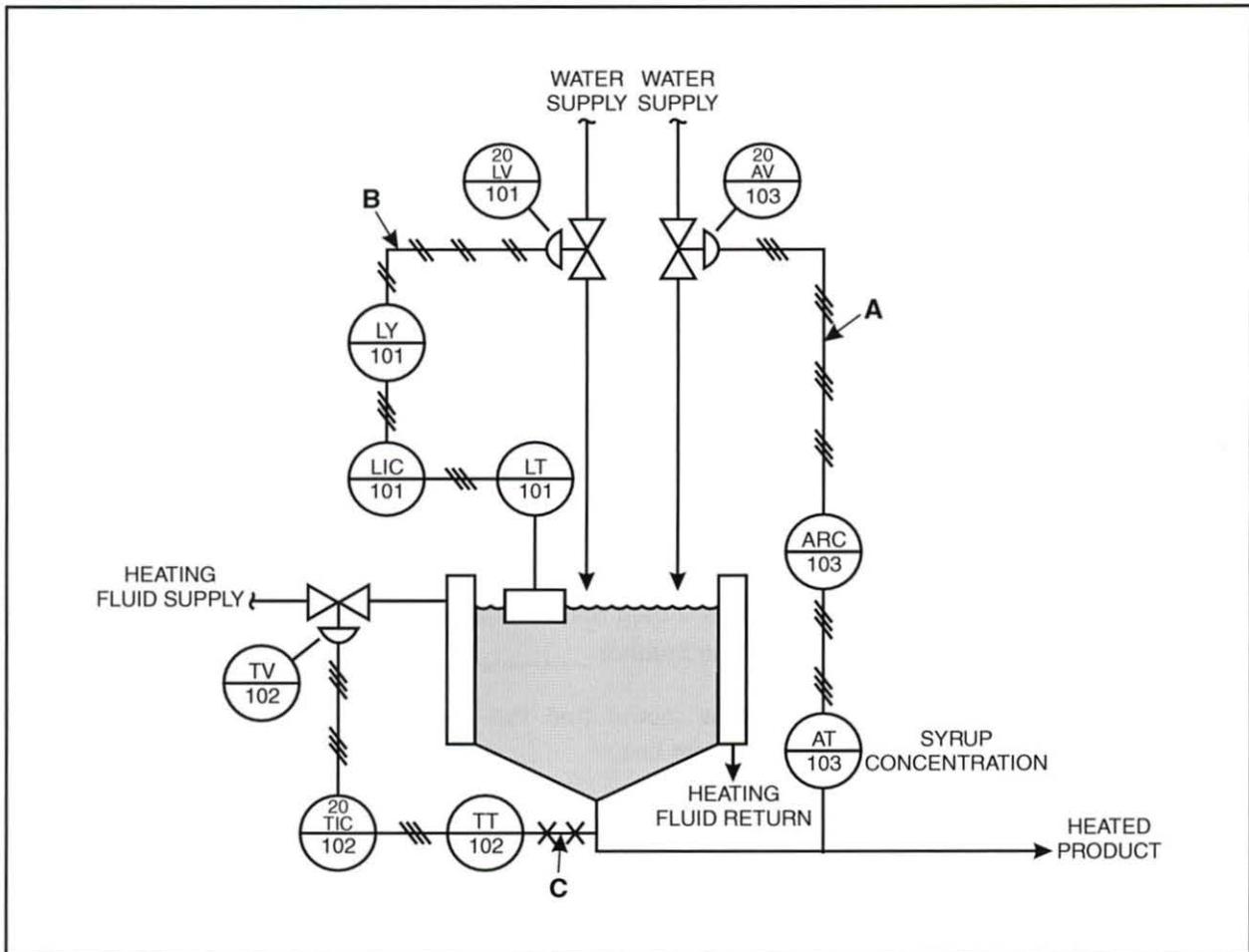


Figure 12. Heating and Mixing System P&ID

A. Line Symbol _____

You should find that the line symbol indicates an electrical line.

B. Line Symbol _____

You should find that the line symbol indicates a pneumatic line.

C. Line Symbol _____

You should find that the line symbol indicates a capillary tube.

9. Identify the line symbol that each letter indicates.

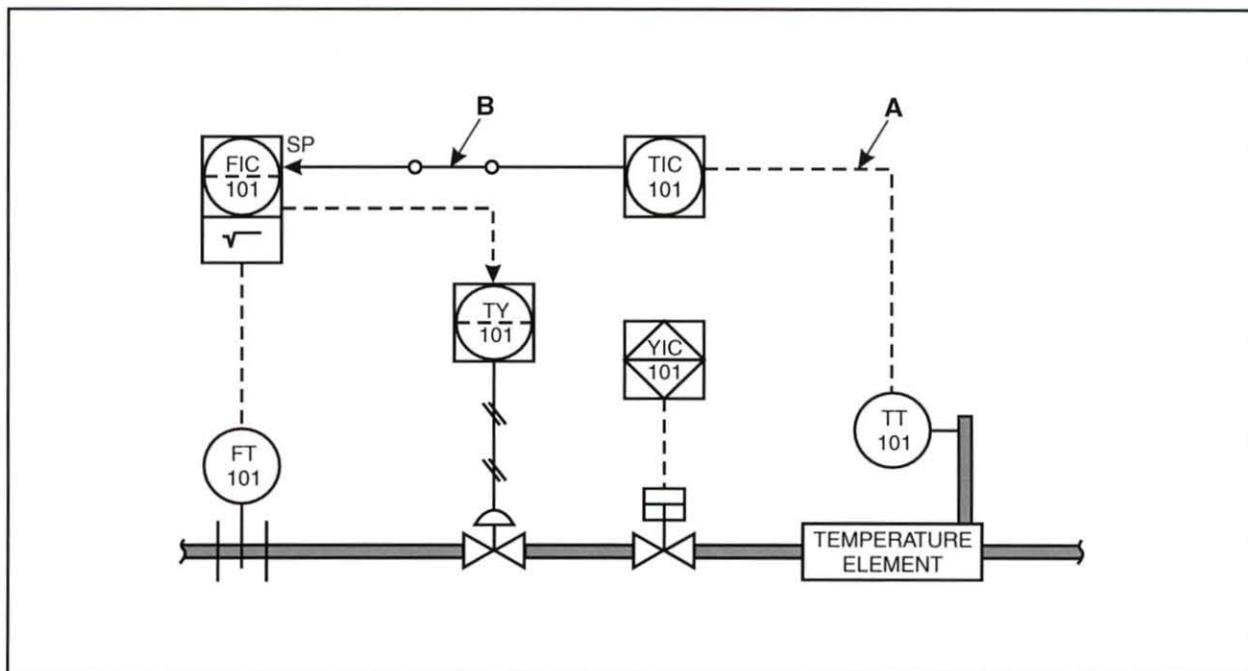


Figure 13. Temperature Control P&ID

A. Line Symbol _____

You should find that the line symbol indicates an electrical line.

B. Line Symbol _____

You should find that the line symbol indicates an internal system link.



1. A _____, is a diagram that shows the layout of an entire process or section of a process.
2. When a P&ID shows a single loop within a process, it is called _____.
3. A line with two slashes through it represents a(n) _____ line on a flow diagram.
4. A dashed line on a flow diagram represents a(n) _____ line.
5. P&IDs do not indicate the physical location of a device, the spatial distance between devices or the _____ of each device.
6. A line with a backslash through it represents a _____ signal.

SEGMENT 2

VALVE AND PUMP SYMBOLS

OBJECTIVE 5

DESCRIBE 11 P&ID VALVE SYMBOLS



The majority of final control elements in a process control system are either pumps or valves. There are many types of valves, like the one in figure 14, that can be used to control a process. Each type of valve has unique operating characteristics and therefore requires a unique symbol to identify it in a P&ID

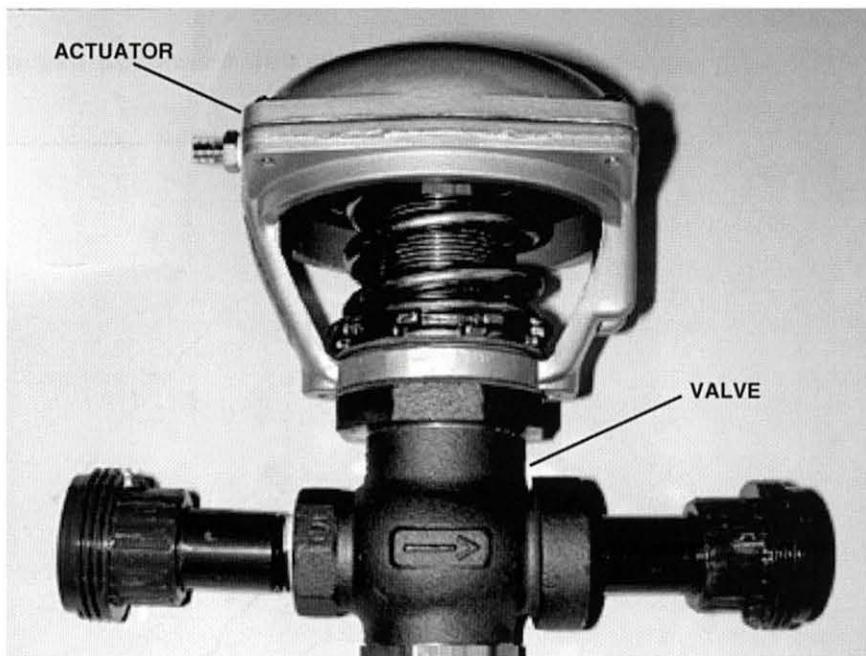


Figure 14. Valve with Actuator

The most common symbol used to represent a valve in a P&ID is two triangles with their points touching in the middle, as shown in figure 15. This symbol is often called the bowtie.

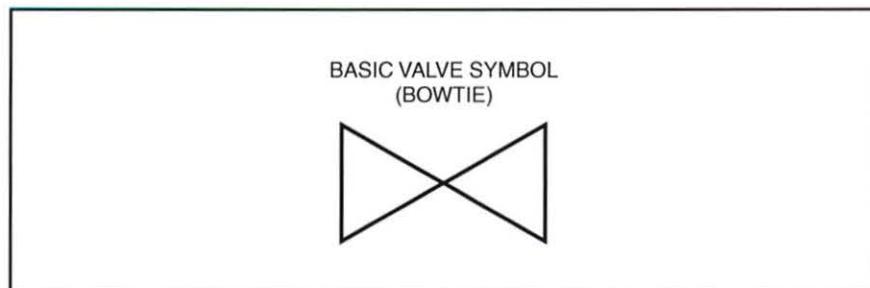


Figure 15. Basic Valve Symbol

The valve symbol can be drawn differently to represent other commonly used valves such as an angle valve, a diaphragm valve, a pinch valve, and a four-way valve. In addition, some special-purpose valves have symbols that are unique to that particular valve. Figure 16 shows examples of these different valve symbols.

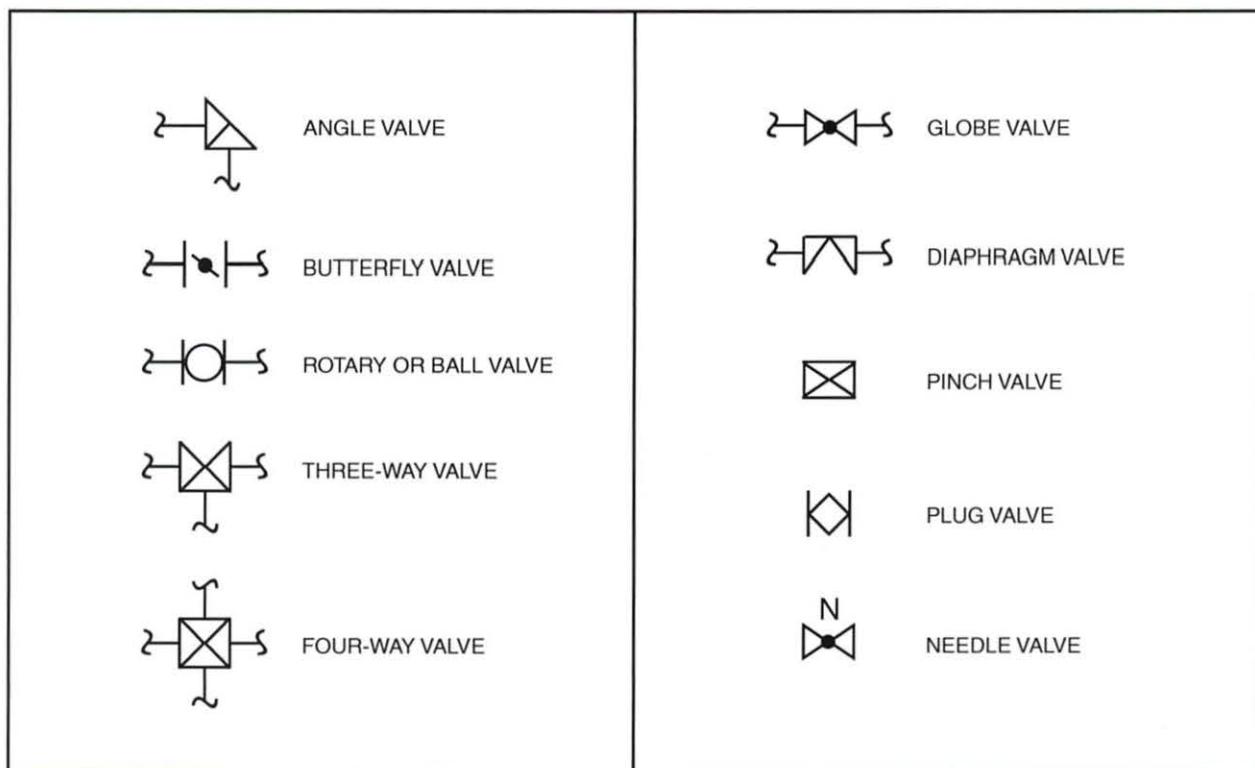


Figure 16. Valve Symbols



The part of the valve that controls the valve stem position is called an actuator. There are many types of actuators available and each has a unique symbol. The actuator symbol is attached to the top of the valve symbol, as shown in figure 17.

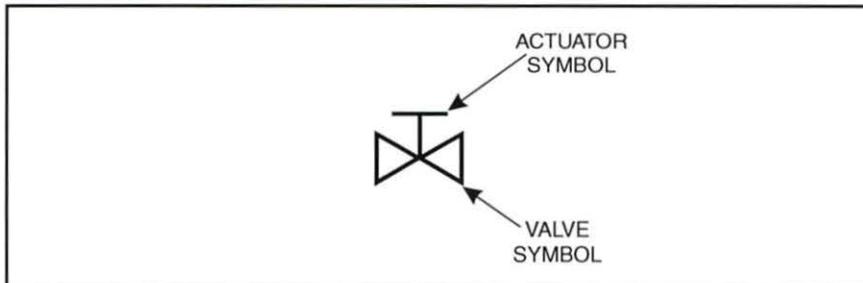


Figure 17. Location of Actuator Symbol

The most basic valve actuator is the hand-actuator, as shown in figure 18. This type of actuator requires a person to manually operate the valve. Notice that the hand-actuator symbol is the shape of a "T" and looks similar to a handle.

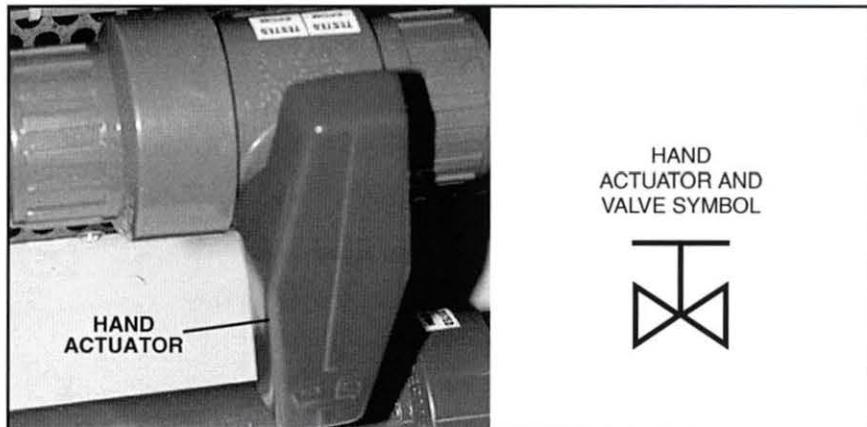


Figure 18. A Hand Valve Actuator and Its Symbol

One of the most common valve actuators in closed loop control is the diaphragm actuator, as shown in figure 19. Diaphragm actuators use compressed air to press on a diaphragm. Notice that the symbol for a diaphragm actuator includes a dome.

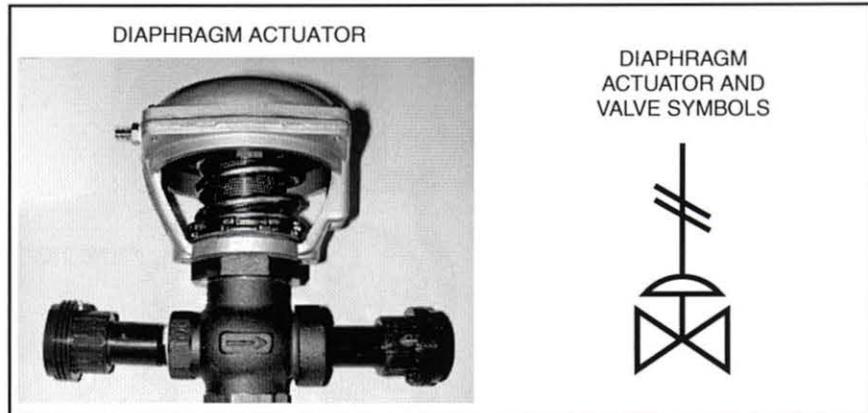


Figure 19. A Diaphragm Valve Actuator and Its Symbol

Another common type of valve actuator is the solenoid valve actuator, as shown in figure 20. Notice that a solenoid actuator symbol is square and contains an "S" for solenoid.

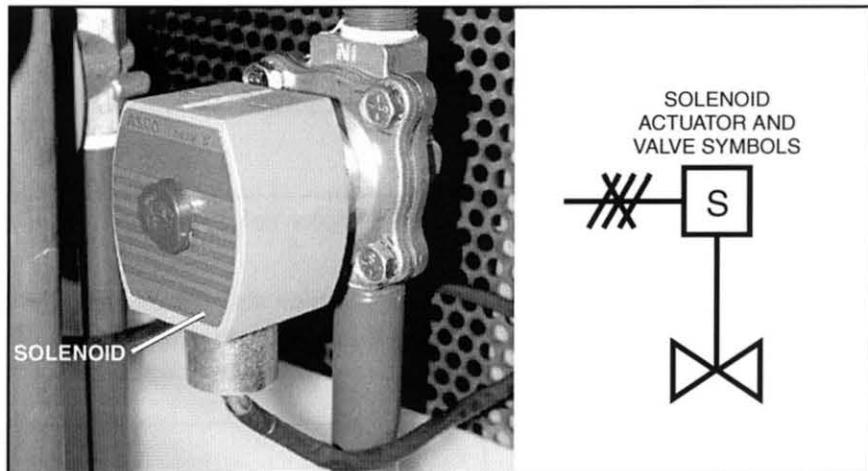


Figure 20. A Solenoid Valve Actuator and Its Symbol

For large valves, requiring higher torque to open and close, an electric motor may actuate the valve, as figure 21 shows. The symbol for a motor valve actuator is a circle that contains an “M” for motor.

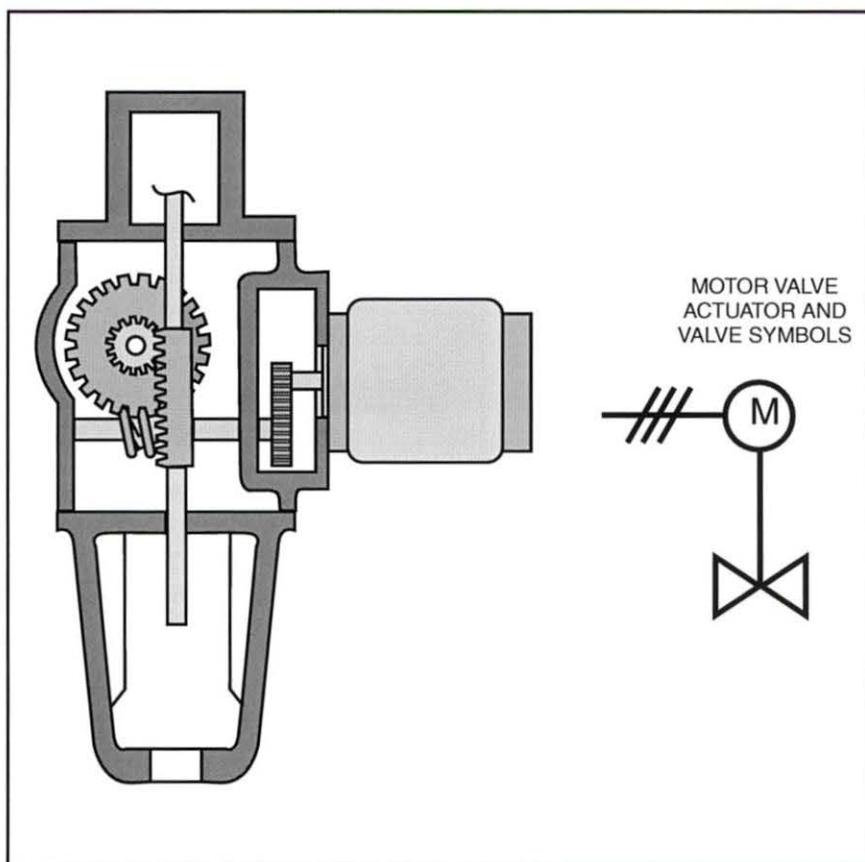


Figure 21. Motor Valve Actuator and Its Symbol

Some valves also have positioners. A positioner is a device that controls the movement of an actuator. For example, figure 22 shows the symbol for a diaphragm valve actuator with a positioner.

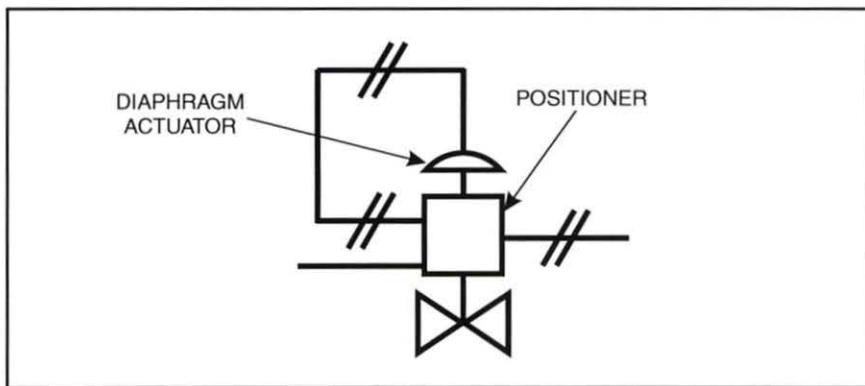


Figure 22. Diaphragm Valve Actuator With a Positioner

Procedure Overview

In this procedure, you will identify flow diagram valve and actuator symbols.



1. Determine the type of valve or actuator symbol depicted in figure 23.

Symbol _____

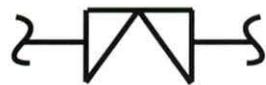


Figure 23. Valve Symbol

You should find that the symbol indicates a diaphragm valve.

2. Determine the type of valve or actuator symbol depicted in figure 24.

Symbol _____



Figure 24. Valve Symbol

You should find that the symbol indicates a plug valve because the tag shows two parallel lines with a diamond between them.

3. Determine the type of valve or actuator symbol depicted in figure 25.

Symbol _____

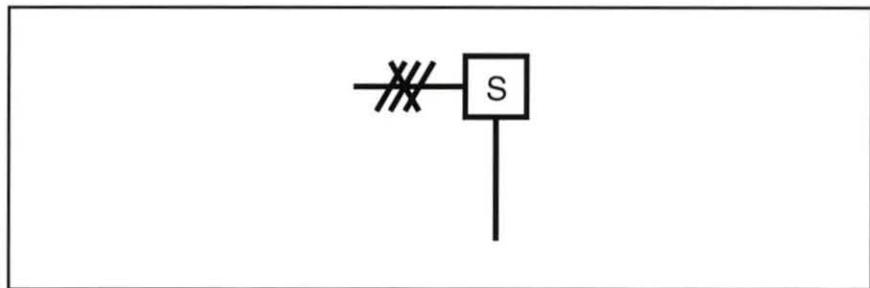


Figure 25. Actuator Symbol

You should find that the symbol indicates a solenoid actuator valve. Recall that the S in the square stands for solenoid.

4. Determine the type of valve or actuator symbol depicted in figure 26.

Symbol _____

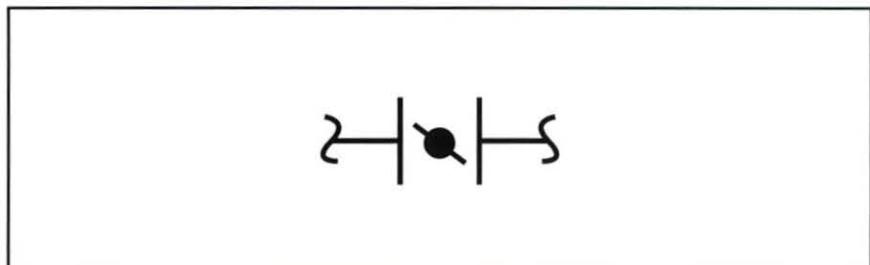


Figure 26. Valve Symbol

You should find that the symbol indicates a butterfly valve.

5. Determine the type of valve or actuator symbol depicted in figure 27.

Symbol _____

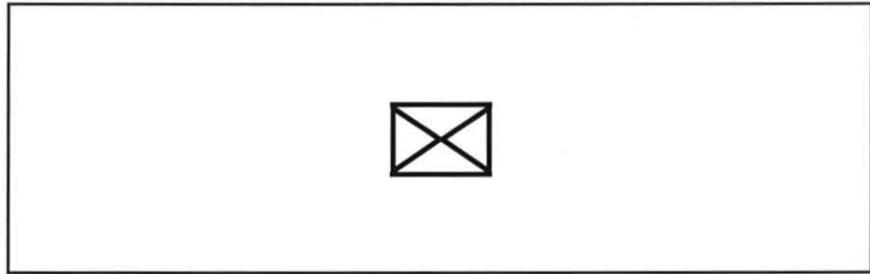


Figure 27. Valve Symbol

You should find that the symbol indicates a pinch valve because the tag shows two intersecting bowtie symbols that form a square with an X in the center. You should also notice that there are no connections extending from the sides of the square.

6. Determine the type of valve or actuator symbol depicted in figure 28.

Symbol _____

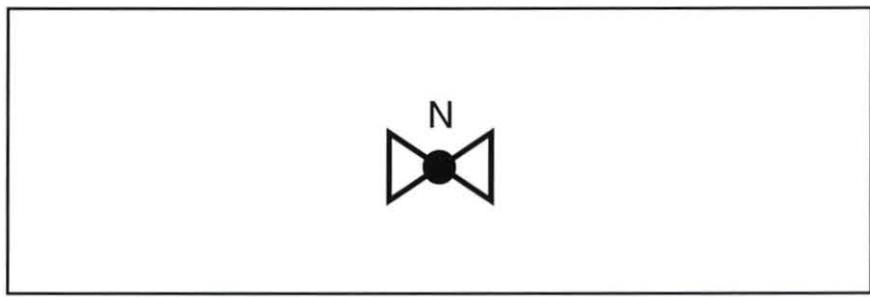


Figure 28. Valve Symbol

You should find that the symbol indicates a needle valve. The N in the symbol identifies it as a needle valve. If the N were not present, it would be a globe valve symbol.

7. Determine the type of valve or actuator symbol depicted in figure 29.

Symbol _____

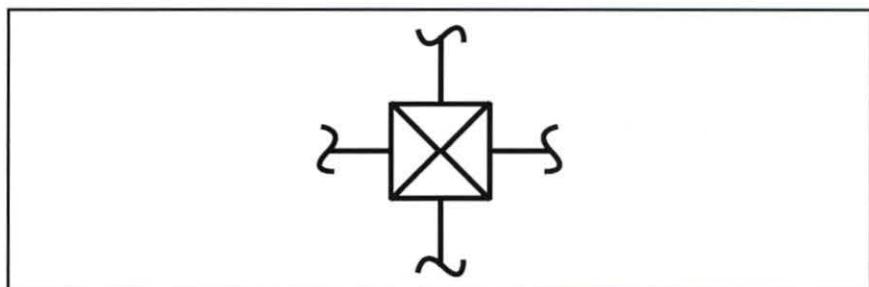


Figure 29. Valve Symbol

You should find that the symbol indicates a four-way valve because the tag shows a square with an X in the center and a connection extending from each side.

8. Determine the type of valve or actuator symbol depicted in figure 30.

Symbol _____

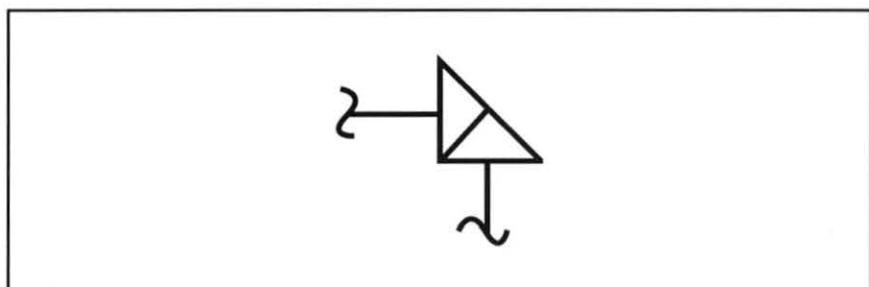


Figure 30. Valve Symbol

You should find that the symbol indicates an angle valve.

9. Determine the type of valve or actuator symbol depicted in figure 31.

Symbol _____

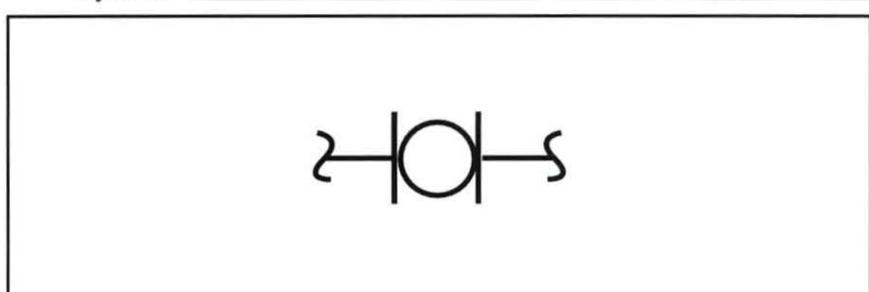


Figure 31. Valve Symbol

You should find that the symbol indicates a rotary valve because the tag shows two parallel lines with a circle between them.

- 10. Determine the type of valve or actuator symbol depicted in figure 32.

Symbol _____

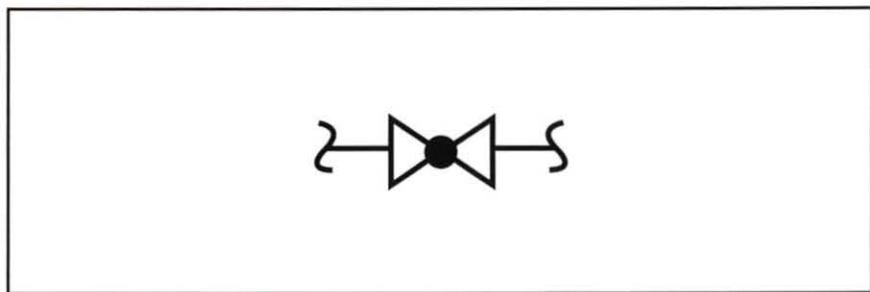


Figure 32. Valve Symbol

You should find that the symbol indicates a globe valve. Notice that the tag is a bowtie symbol with a large dot (which you can think of as a globe) at the point of intersection. You should also notice that there is a connection extending from each side.

- 11. Identify the valve and valve actuator symbols indicated by the letters.

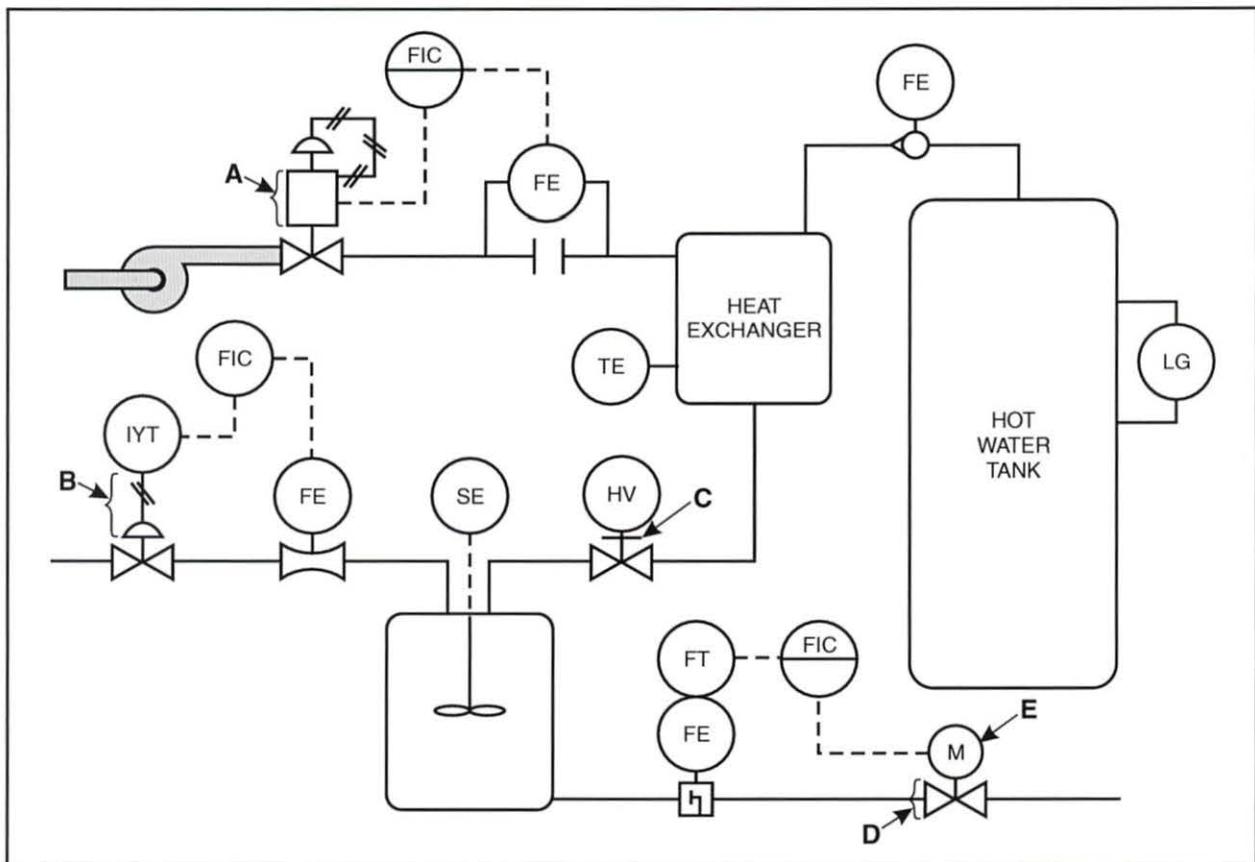


Figure 33. Valve and Valve Actuator Symbols on a P&ID

A. Symbol _____

You should find that the symbol indicates a positioner.

B. Symbol _____

You should find that the symbol indicates a diaphragm actuator.

C. Symbol _____

You should find that the symbol indicates a hand valve actuator.

D. Symbol _____

You should find that the symbol indicates a valve.

E. Symbol _____

You should find that the symbol indicates a motor valve actuator.

OBJECTIVE 7

DESCRIBE THREE P&ID PUMP SYMBOLS



Pumps are one of several types of final control elements in process systems, moving the process fluid from point to point. Figure 34 shows the symbol for three common types of pumps.

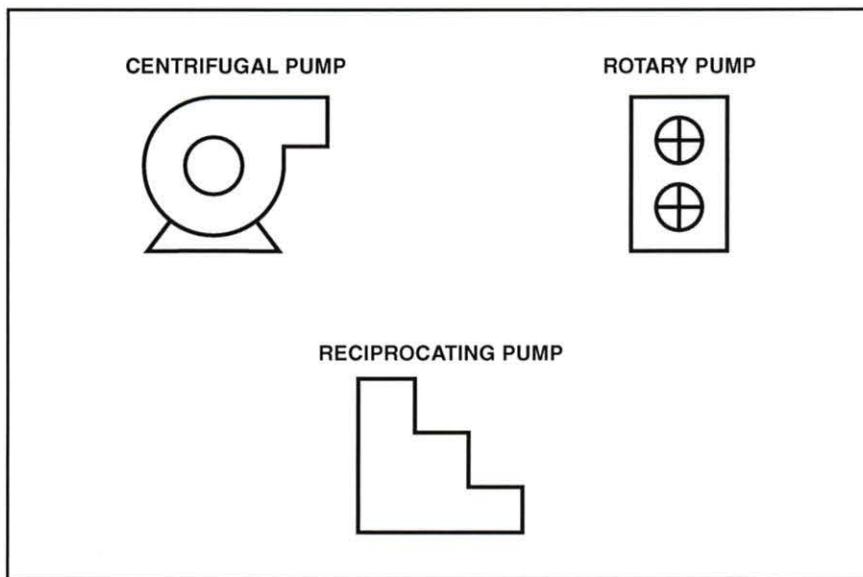


Figure 34. P&ID Symbols for Centrifugal, Rotary, and Reciprocating Pumps

Procedure Overview

In this procedure, you will examine a P&ID and identify the different pumps used in the system.



- 1. Identify the pump symbol that each letter indicates.

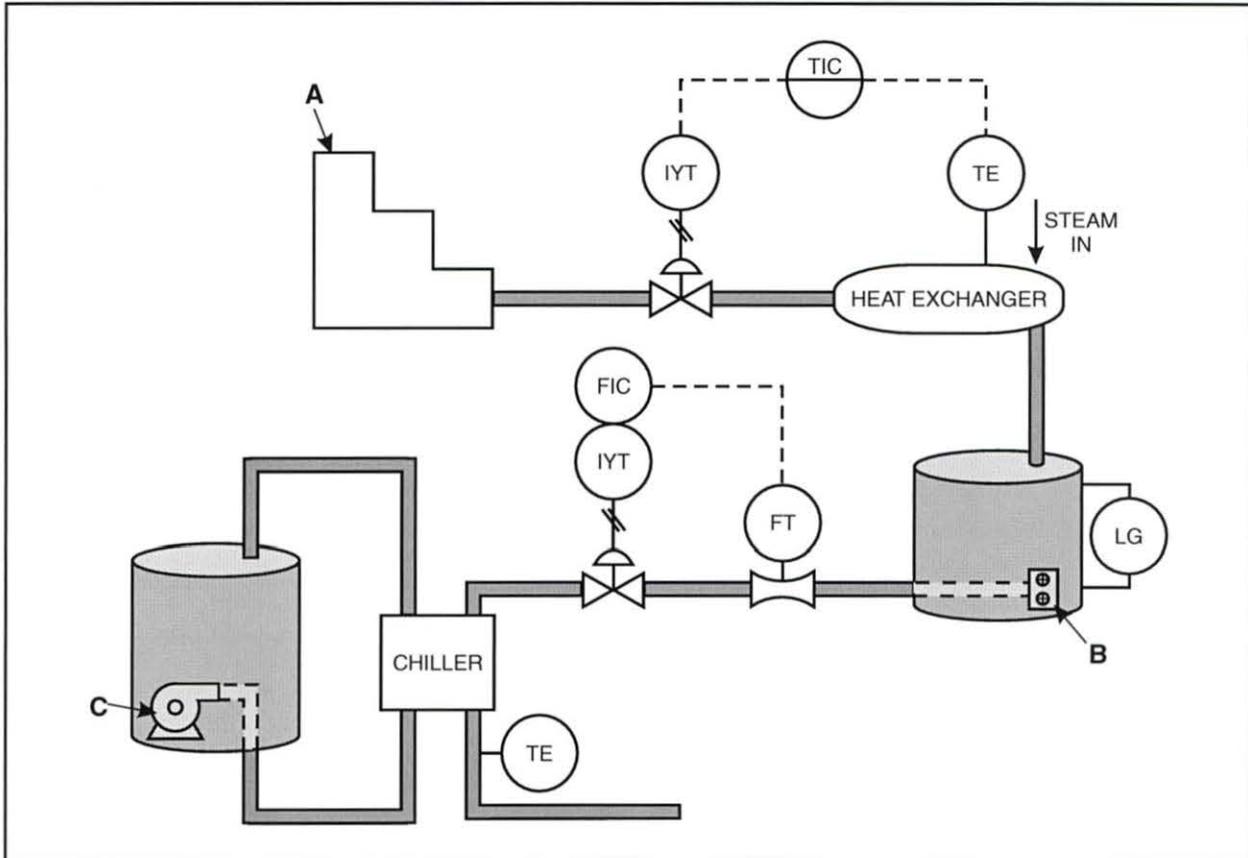


Figure 35. P&ID of Liquid Heating and Cooling Process

A. Pump Symbol _____

You should find that the symbol indicates a reciprocating pump.

B. Pump Symbol _____

You should find that the symbol indicates a rotary pump.

C. Pump Symbol _____

You should find that the symbol indicates a centrifugal pump.



1. The basic valve symbol is often referred to as a _____ because of its shape.
2. The most basic valve actuator is the _____ actuator, which requires a person to manually operate the valve.
3. A _____ valve actuator is represented by a symbol that has a square with the letter S inside.
4. A _____ is a device that controls the movement of an actuator.
5. The most common types of final control elements are valves and _____.
6. The three most common types of pumps are reciprocating, centrifugal, and _____ pumps.

SEGMENT 3

LEVEL AND FLOW SENSING ELEMENTS

OBJECTIVE 8

DESCRIBE 10 P&ID LIQUID LEVEL SENSING ELEMENT SYMBOLS



Figure 36 shows 10 common liquid level element symbols used in P&IDs. Notice that some of the symbols indicate how the device is mounted and some indicate the method the device uses to transmit data to the control loop. This information helps to determine the principle on which the device operates.

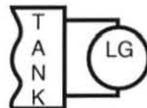
P & ID LEVEL ELEMENT SYMBOLS



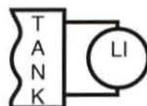
GAUGE GLASS,
MOUNTED ON TANK



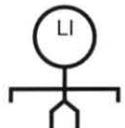
LEVEL TRANSMITTER,
DIFFERENTIAL PRESSURE TYPE,
MOUNTED ON TANK



GAUGE GLASS
EXTERNALLY CONNECTED



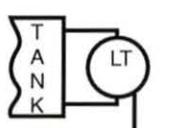
LEVEL INDICATOR,
WITH TWO CONNECTIONS



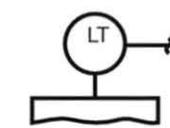
LEVEL INDICATOR,
FLOAT TYPE



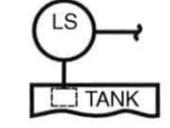
LEVEL TRANSMITTER,
ONE CONNECTION



LEVEL TRANSMITTER,
DIFFERENTIAL PRESSURE TYPE,
WITH TWO CONNECTIONS



LEVEL TRANSMITTER,
CAPACITANCE OR
DIELECTRIC TYPE



LEVEL SWITCH,
PADDLE WHEEL OR
LEVER TYPE

Figure 36. P&ID Level Element Symbols

Procedure Overview

In this procedure, you will identify level sensing element symbols.



1. Determine what type of level sensing element symbol is shown in figure 37.

Symbol _____

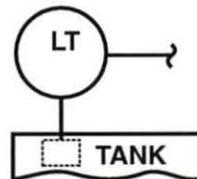


Figure 37. Level Sensing Element Symbol

You should find that the symbol indicates a level switch.

2. Determine what type of level sensing element symbol is shown in figure 38.

Symbol _____

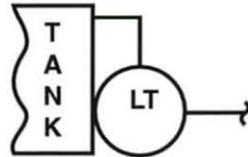


Figure 38. Level Sensing Element Symbol

You should find that the symbol indicates a mounted differential pressure level transmitter.

3. Determine what type of level sensing element symbol is shown in figure 39.

Symbol _____

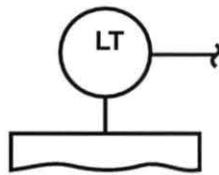


Figure 39. Level Sensing Element Symbol

You should find that the symbol indicates a capacitance level transmitter.

4. Determine what type of level sensing element symbol is shown in figure 40.

Symbol _____

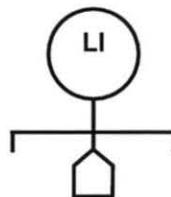


Figure 40. Level Sensing Element Symbol

You should find that the symbol indicates a level float indicator.

5. Determine what type of level sensing element symbol is shown in figure 41.

Symbol _____



Figure 41. Level Sensing Element Symbol

You should find that the symbol indicates a gauge glass mounted on the tank.

6. Determine what type of level sensing element symbol is shown in figure 42.

Symbol _____

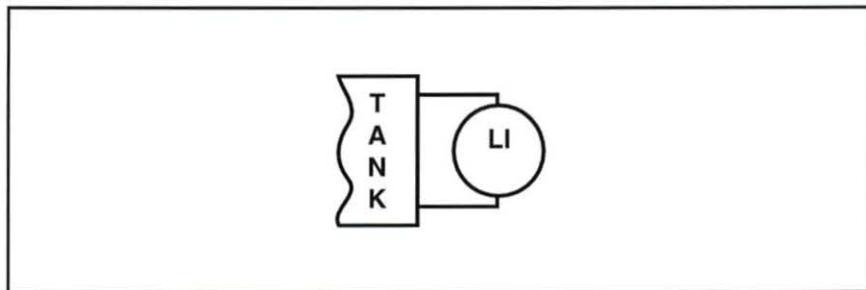


Figure 42. Level Sensing Element Symbol

You should find that the symbol indicates a level indicator with two connections.

7. Determine what type of level sensing element symbol is shown in figure 43.

Symbol _____

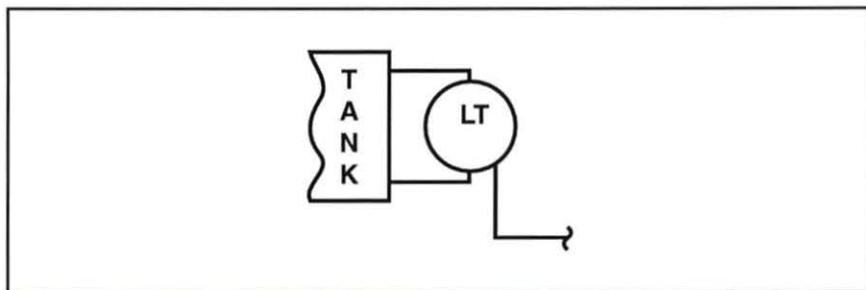


Figure 43. Level Sensing Element Symbol

You should find that the symbol indicates a differential pressure level transmitter with two connections.

8. Determine what type of level sensing element symbol is shown in figure 44.

Symbol _____

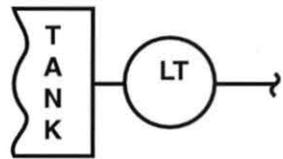


Figure 44. Level Sensing Element Symbol

You should find that the symbol indicates a level transmitter with one connection.

9. Determine what type of level sensing element symbol is shown in figure 45.

Symbol _____

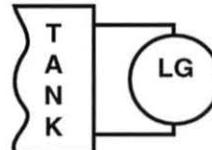


Figure 45. Level Sensing Element Symbol

You should find that the symbol indicates a gauge glass, externally mounted.



Figure 46 shows 11 symbols used to represent various types of flow sensing devices.

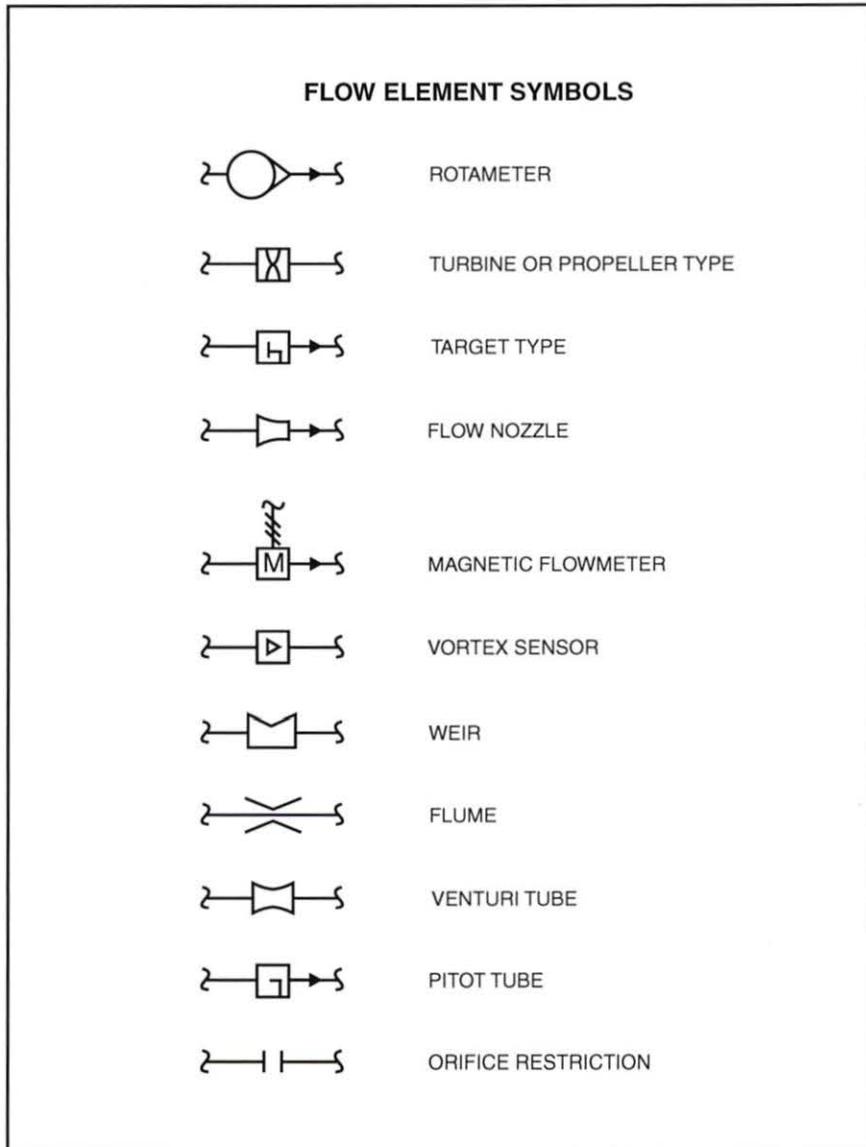


Figure 46. Flow Element Symbols

Procedure Overview

In this procedure, you will identify the flow sensing element symbols.



1. Determine what type of flow sensing element symbol is shown in figure 47.

Symbol _____

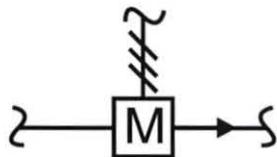


Figure 47. Flow Sensing Element Symbol

You should find that the symbol indicates a magnetic flow meter.

2. Determine what type of flow sensing element symbol is shown in figure 48.

Symbol _____

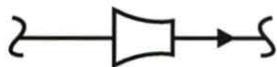


Figure 48. Flow Sensing Element Symbol

You should find that the symbol indicates a flow nozzle.

3. Determine what type of flow sensing element symbol is shown in figure 49.

Symbol _____



Figure 49. Flow Sensing Element Symbol

You should find that the symbol indicates a vortex sensor.

4. Determine what type of flow sensing element symbol is shown in figure 50.

Symbol _____

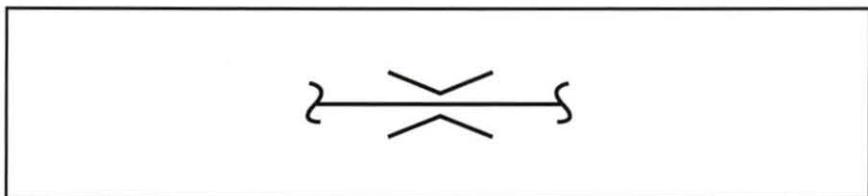


Figure 50. Flow Sensing Element Symbol

You should find that the symbol indicates a flume.

5. Determine what type of flow sensing element symbol is shown in figure 51.

Symbol _____

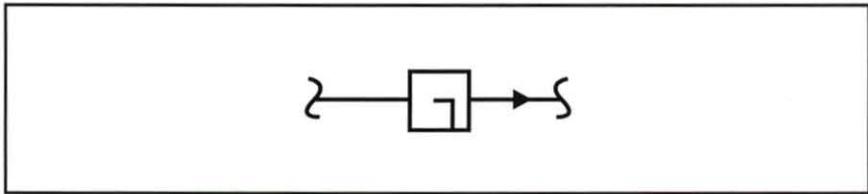


Figure 51. Flow Sensing Element Symbol

You should find that the symbol indicates a pitot tube.

6. Determine what type of flow sensing element symbol is shown in figure 52.

Symbol _____

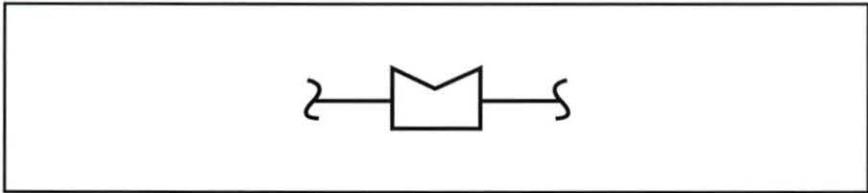


Figure 52. Flow Sensing Element Symbol

You should find that the symbol indicates a weir.

7. Determine what type of flow sensing element symbol is shown in figure 53.

Symbol _____

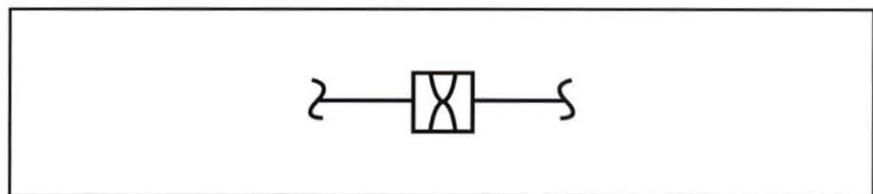


Figure 53. Flow Sensing Element Symbol

You should find that the symbol indicates a turbine type flow meter.

8. Identify the flow sensing elements that each letter indicates.

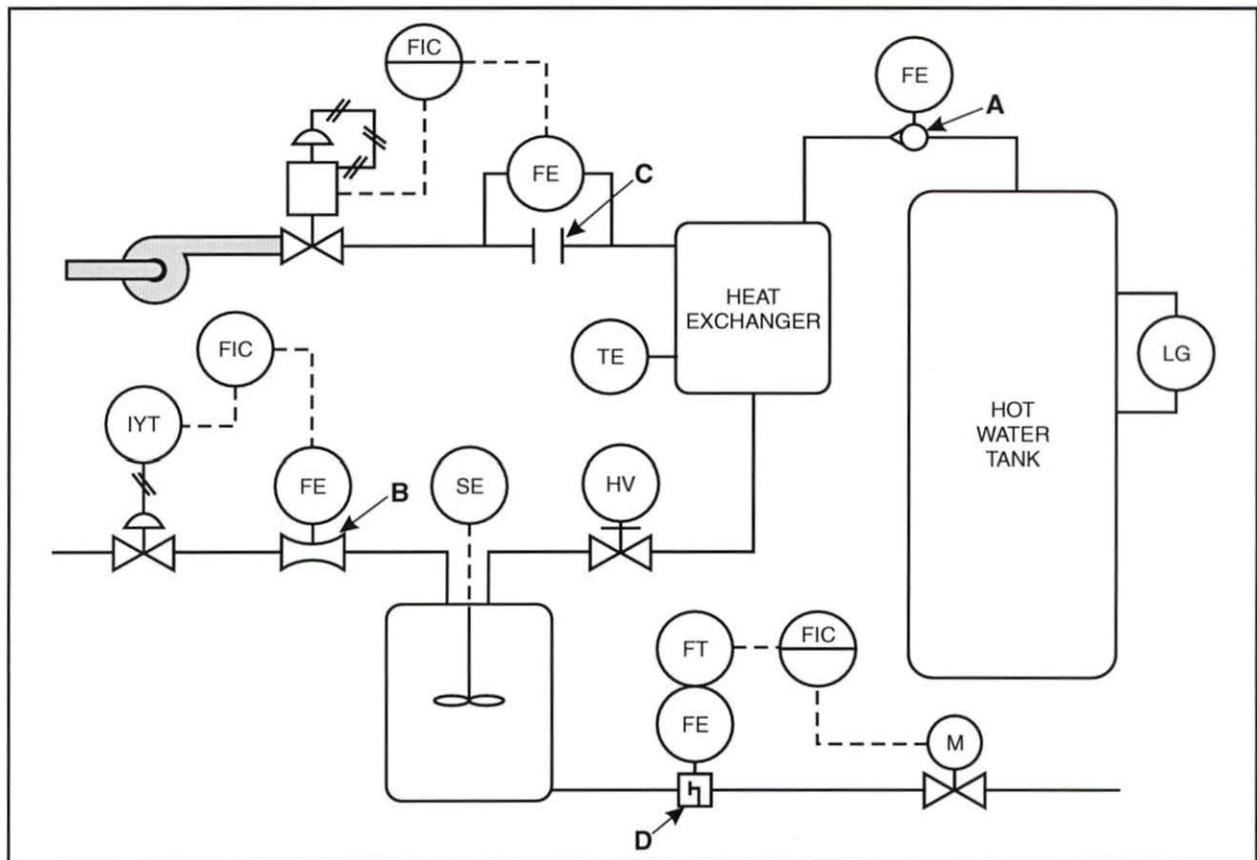


Figure 54. Sample P&ID

A. Symbol _____

You should find that the symbol indicates a rotameter.

B. Symbol _____

You should find that the symbol indicates a Venturi tube.

C. Symbol _____

You should find that the symbol indicates an orifice restriction.

D. Symbol _____

You should find that the symbol indicates a target flow sensor.



1. A rotameter is an example of a _____ sensing element.
2. A bubble with the identifiers “LG” inside it represents a _____, either mounted on the tank or externally connected.
3. Some _____ sensing element symbols indicate the method the device uses to transmit data to the control loop.
4. A square with an “X” in the center indicates a _____ type flow sensor.
5. A square with an arrowhead pointing to the right indicates a _____ flow sensor.

SEGMENT 4

PRESSURE AND TEMPERATURE SENSING ELEMENTS

OBJECTIVE 10

DESCRIBE TWO P&ID PRESSURE SENSING ELEMENT SYMBOLS



Pressure elements are represented by a standard symbol tag, as figure 55 shows.

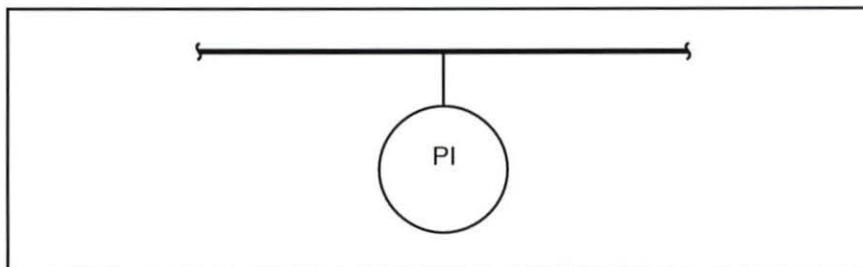


Figure 55. Standard Pressure Sensing Element Symbol

While most pressure elements don't have special symbols to represent them, they do use components that help isolate the device from the system. One example is a diaphragm.

Diaphragms are devices that can be used to isolate the sensing element from the process or they can be used to separate two transmission mediums from each other. An example of this is an application where an air signal is converted to a liquid signal. A diaphragm is used to separate the liquid from the air.

The symbol for a diaphragm is shown in figure 56.

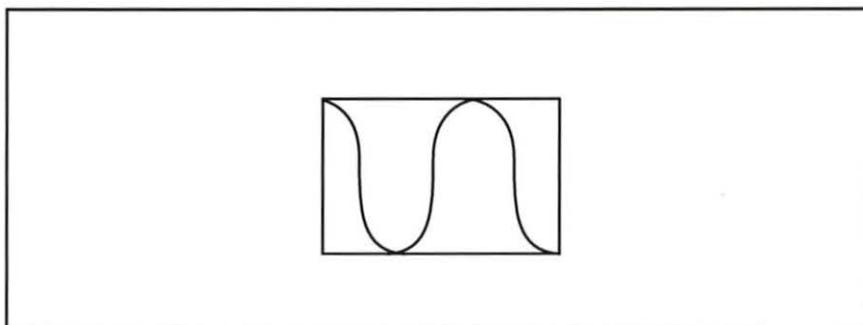


Figure 56. Symbol for a Diaphragm

Figure 57 shows a pressure element connected to the process line through a diaphragm.

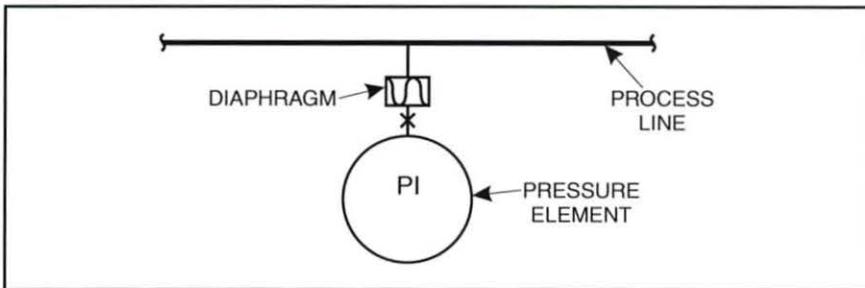


Figure 57. Pressure Element Connected to Process Line Through a Diaphragm



A standard symbol tag also represents temperature elements, as shown in figure 58.

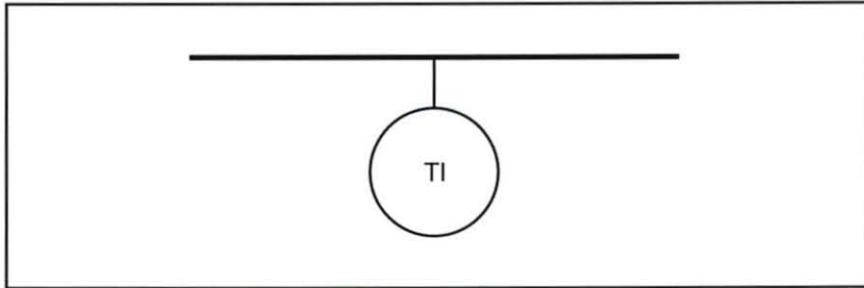


Figure 58. Temperature Sensing Element Symbol

Many temperature element symbols also indicate how the element is connected to the process. For example, if the connection line for a temperature element is drawn with a circle around it, the element is separated from the process by a device called a thermocouple well (often referred to as a thermowell), as shown in figure 59.

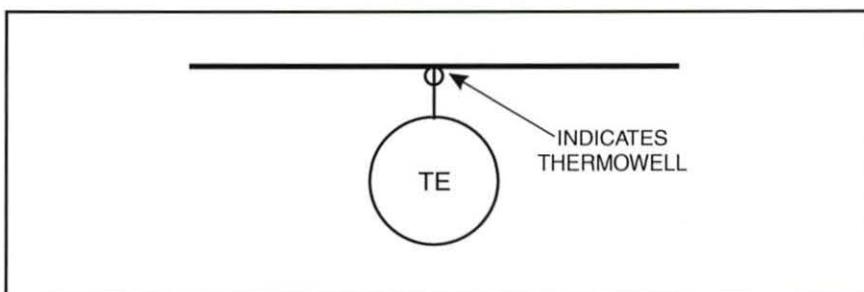


Figure 59. Symbol for Temperature Sensing Element in a Thermowell

Thermowells are hollow tubes in which the temperature element is placed to protect the temperature element from the process, as figure 60 shows. This is useful when the device must sense the temperature of a caustic fluid that would adversely react with the materials that make up the temperature element.

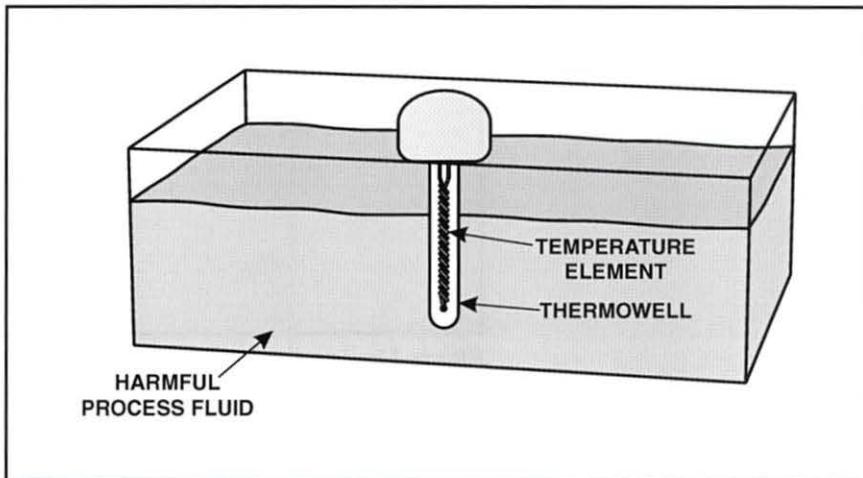


Figure 60. A Temperature Element in a Thermowell

Another type of temperature element connection is a surface-mount, where the temperature element is mounted to the outer surface of the vessel or piping that contains the process fluid. The symbol for this is a connection line that spreads out to form a T on the process piping, as shown in figure 61.

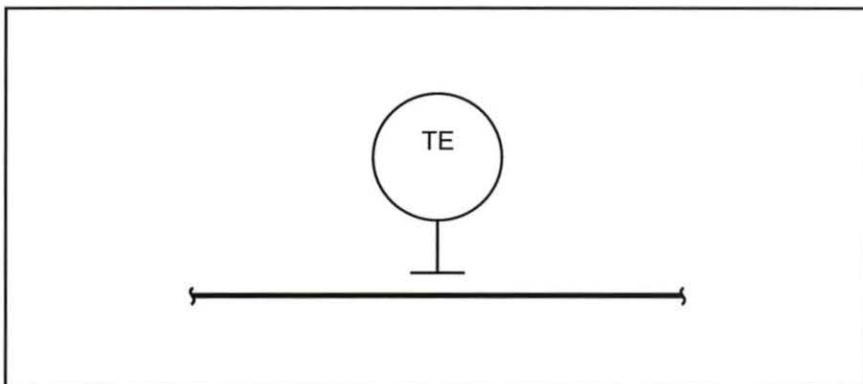


Figure 61. Surface Mounted Temperature Element Symbol

Procedure Overview

In this procedure, you will identify pressure and temperature sensing element symbols.



1. Determine what type of pressure sensing element symbol is shown in figure 62.

Symbol _____

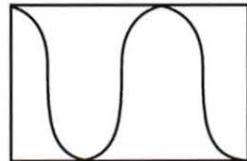


Figure 62. Flow Sensing Element Symbol

You should find that the symbol indicates a diaphragm.

2. Determine what type of temperature sensing element symbol is shown in figure 63.

Symbol _____

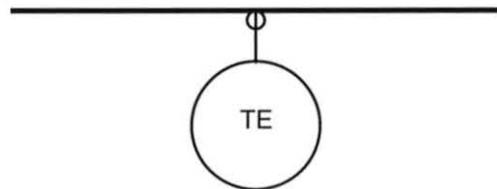


Figure 63. Flow Sensing Element Symbol

You should find that the symbol indicates a temperature element with a thermowell.

3. Determine what type of pressure sensing element symbol is shown in figure 64.

Symbol _____

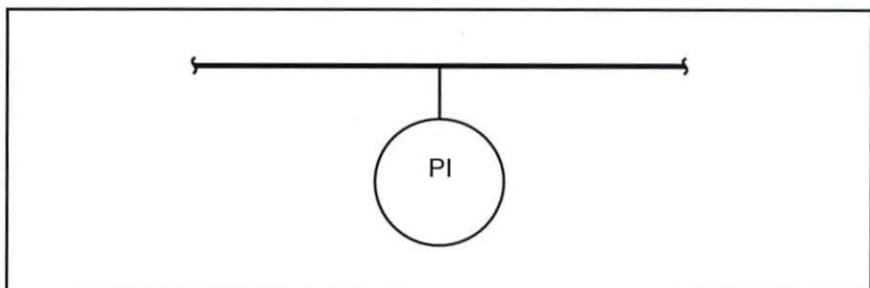


Figure 64. Flow Sensing Element Symbol

You should find that the symbol indicates a standard pressure symbol.

4. Determine what type of temperature sensing element symbol is shown in figure 65.

Symbol _____

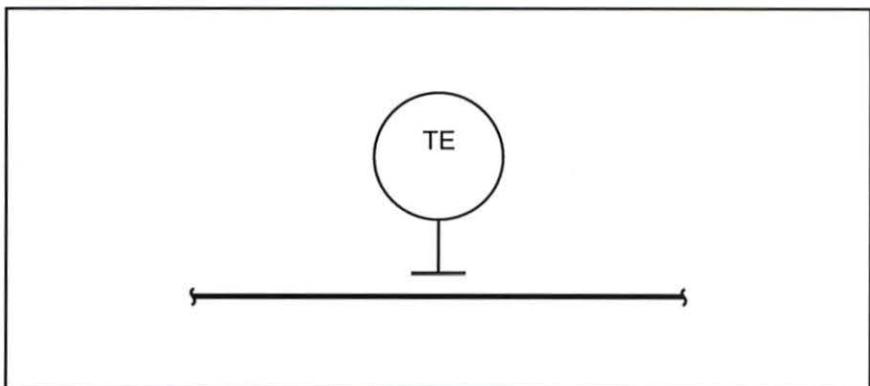


Figure 65. Flow Sensing Element Symbol

You should find that the symbol indicates a surface-mounted temperature sensing element.

5. Determine what type of pressure sensing element symbol is shown in figure 66.

Symbol _____

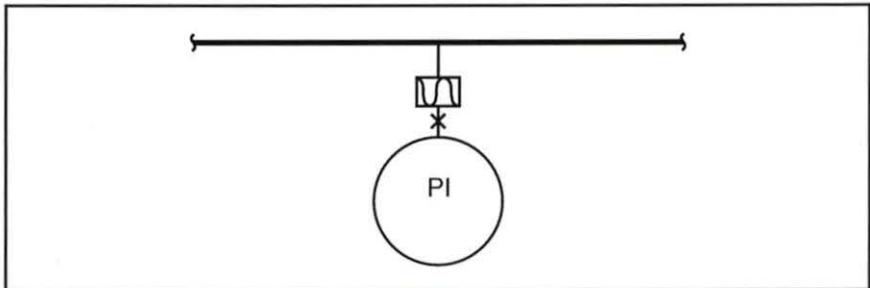


Figure 66. Flow Sensing Element Symbol

You should find that the symbol indicates a standard pressure element connected through a diaphragm.

Procedure Overview

In this procedure, you will draw a P&ID for a given process control system. This process is similar to drawing a schematic diagram for an electrical or fluid power circuit.



1. Draw a P&ID based on the following description. Draw your diagram on a separate piece of paper.

Description:

- The system is a level control loop that controls the level of a liquid in a tank.
- The tank uses two level sensors, one for the high level and the other for the low level.
- These sensors send electrical signals to an electronic level controller, which is mounted in the control room and is accessible to the operator.
- The controller includes a digital display.
- The controller controls the flow into and out of the tank by controlling two solenoid valves, one in the input line and one in the output line. The control loop number is 100.

Your diagram should be similar to the one in figure 67. The instrument tag of the high level sensor should read LSH-100. The instrument tag of the low level sensor should read LSL-100. The instrument tag of the level controller should read LIC-100 and should have a single line through the center (primary location and accessible). The instrument tags for the solenoid valves should read FV-100. However, you might also label them LV-100, since they are being used to control the level in the tank.

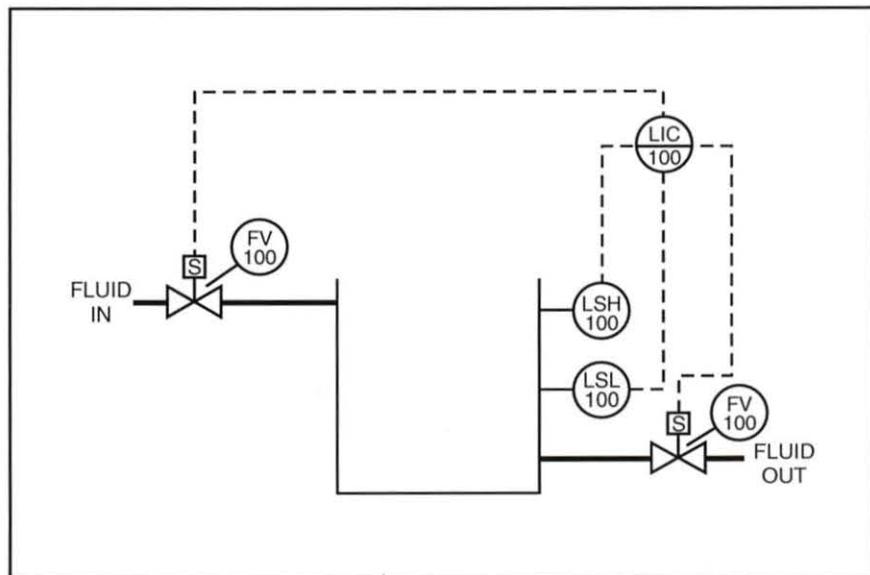


Figure 67. P&ID for Level Control Loop

2. Draw a P&ID based on the following description. Draw your diagram on a separate piece of paper.

Description:

- The system is a pressure control loop that controls the pressure of nitrogen in a tank.
- An electronic pressure controller monitors the pressure in the tank based on feedback transmitted by a pressure sensor that measures the pressure inside the tank.
- The pressure controller is located in a remote control panel away from the control room, but is accessible.
- The controller controls the flow of nitrogen into the tank through a diaphragm-actuated valve.
- Since the output of the controller is an electrical signal, a transducer is needed to convert the electrical signal to a pneumatic signal.
- The controller also controls the venting of gas to the atmosphere through a solenoid valve.
- The control loop number is 50.

3. Draw a P&ID based on the following description. Draw your diagram on a separate piece of paper.

Description:

- The system is a temperature control loop that controls the temperature of the process fluid from a heat exchanger.
- A PLC controls the temperature of the outgoing process fluid based on temperature feedback from a temperature sensor.
- The temperature sensor is enclosed in a thermowell.
- Based on the temperature of the outgoing fluid, the PLC controls the flow of steam into the heat exchanger through a motor-actuated valve.
- The in flow of the process fluid is controlled by another loop.
- A hand-actuated valve is also used to vent steam when necessary.
- The control loop number is 250.

4. Draw a P&ID based on the following description. Draw your diagram on a separate piece of paper.

Description:

- The system is a flow control loop that controls the flow of two liquids into a mixing tank.
- The controller must maintain an exact ratio of the two fluids.
- The controller, a computer located in the control room, controls the flow of each fluid into the tank using motor-actuated valves.
- The flow of the two liquids is measured using venturi tubes with flow transmitters connected to them.
- The flow transmitters, which provide feedback to the controller, are located in primary location but are inaccessible.
- The controller controls the flow of the mixture out of the tank using a diaphragm-actuated valve.
- A transducer is needed to convert the electrical signal from the controller to a pneumatic signal.
- The control loop number is 600.

5. Draw a P&ID for the T5552.

Figure 68 shows a drawing of the T5552 that you can use for reference.

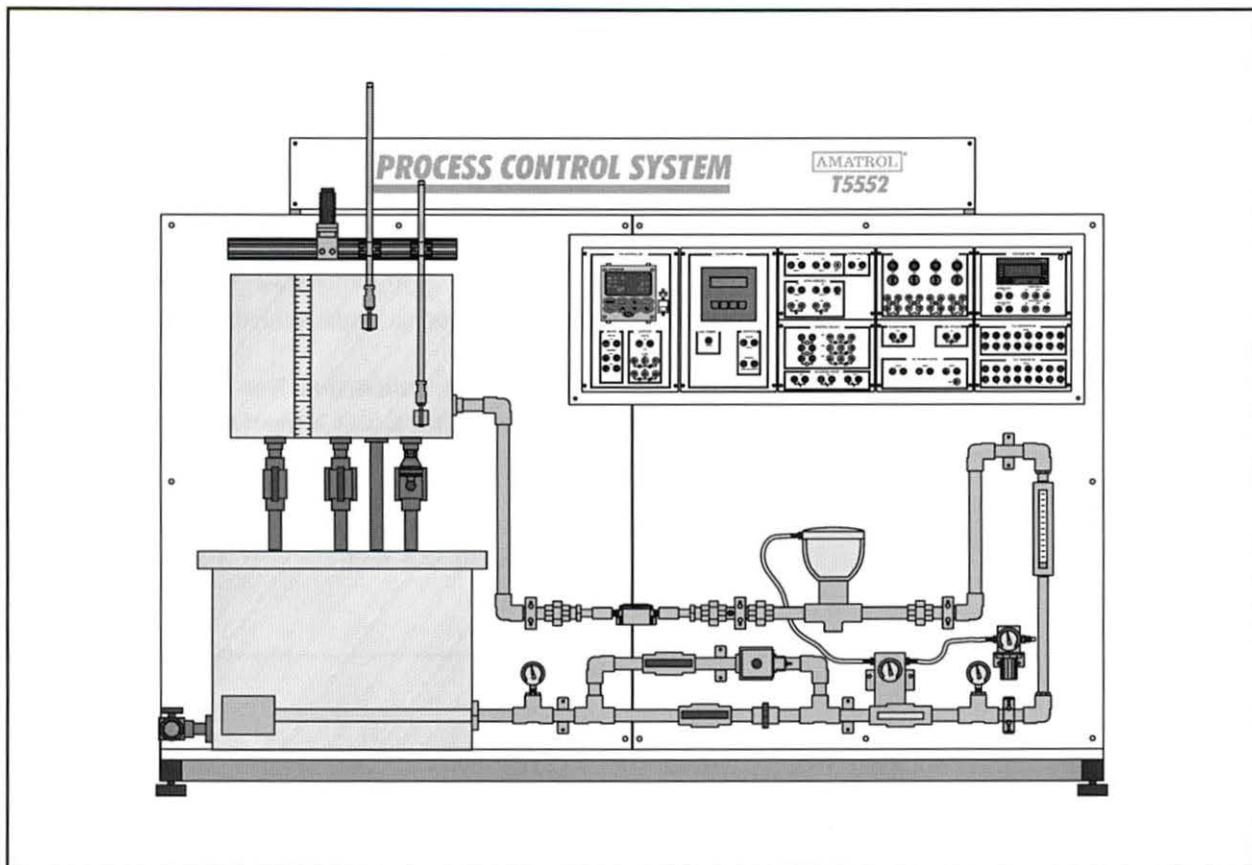


Figure 68. T5552 Process Control System

Your P&ID should include the following components:

- Process Tank
- Reservoir Tank
- Circulation Pump
- All Hand Valves
- All Solenoid Valves
- Pressure Gauges (in the piping network)
- Pressure Transducer
- Level Switches
- Rotameter
- Flow Transmitter
- PID Controller
- I/P Converter
- Pressure Regulator
- Paddlewheel Flow Sensor
- Diaphragm Actuator Proportional Valve



1. On pressure elements, a _____ is used to separate the liquid from the air.
2. Temperature and pressure elements are represented by a _____ symbol tag.
3. _____ are hollow tubes in which the temperature element is placed to protect it from the process.
4. If the temperature element connection line spreads out to form a T on the process piping, the temperature element is _____.
5. A connection line on a temperature element symbol that has a _____ around it indicates that the element is inside a thermocouple well.

SEGMENT 5

INSTRUMENT INDEX

OBJECTIVE 12

DESCRIBE THE FUNCTION OF AN INSTRUMENT INDEX



An instrument index is a document that lists every instrument in the process by tag number and the numbers of the drawings on which it can be found. A typical process system has a number of documents associated with it. These include P&IDs, installation drawings, and instrument specifications. An instrument index brings all of this information together so that you can quickly locate the documents you need. Figure 69 shows a typical instrument index.

AREA PREFIX TAG NO.	SERVICE	LOCATION	MFR	SPEC SHEET NO.	P & I DWG NO.	LOOP-SHEET DWG NO.	LOCATION & ROUTING DRAWING NO.	INSTL DETAIL DWG NO.	PIPING DWG NO.	ELECT DWG NO.	VENDOR DWG NO.	NOTES
LAH-1	Cooling Tower Level	PV	ACME	03-LA-1	03-P-100	03-L-1	-----	-----	-----	-----	-----	P.O. NO. 249-126
LAL-1	Cooling Tower Level	PV	ACME	03-LA-1	03-P-100	03-L-1	-----	-----	-----	-----	-----	P.O. NO. 249-126
LIC-1	Cooling Tower Level	L	Jones	03-C-2	03-P-100	03-L-1	03-I-600	65-I-502	-----	-----	-----	P.O. NO. 249-290
LSH-1	Cooling Tower Level	L	US Inst.	03-LS-1	03-P-100	03-L-1	03-I-600	-----	-----	-----	-----	P.O. NO. 249-423
LT-1	Cooling Tower Level	F	Smith	03-LT-1	03-P-100	03-L-1	03-I-600	03-I-600	03-P-200	-----	-----	P.O. NO. 249-612
LV-1	Cooling Tower Level	F	Honey	0V-V-2	03-P-100	03-L-1	03-I-600	65-I-523	03-P-200	-----	-----	P.O. NO. 249-612
PC-1	Cooling Tower Recirculation Water Pressure	F	Fisher	03-V-005	03-P-100	03-P-002	03-I-600	65-I-502 65-I-540A	03-P-200	-----	-----	P.O. NO. 249-083

					LOCATION LEGEND	DRAWN BY: WORD PROCESS.	DATE 4/26/92	A B & C ENGINEERING			NO. 2 COOLING TOWER	
					B - BACK OF PANEL	DESIGNED BY	DATE 3/29/92	A B & C ENGINEERING			CONTRACT NO. ABC-249	
					D - DIGITAL SOFTWARE	CHECKED BY	DATE 5/05/92				SHEET 1 OF 3 INSTRUMENT INDEX	
					E - EXISTING	APPROVED BY	DATE	INSTRUMENT INDEX				
					F - FIELD	RELEASED BY	DATE 5/07/92					
1	8/5/92	ADDED HEAT TRACE I.D.			L - LOCAL PANEL							
0	5/7/92	RELEASED FOR CONSTRUCTION			P - FRONT OF PANEL							
NO.	DATE	REVISIONS	DSGN	CKD	B - BACK							
					V - VENDOR PACKAGE							

Figure 69. An Instrument Index

OBJECTIVE 13

DESCRIBE HOW TO INTERPRET THE INFORMATION CONTAINED IN AN INSTRUMENT INDEX



An instrument index can be organized in several ways depending on the process system it documents. The items labeled in figure 70 represent information commonly found on an instrument index. These items are described as follows:

Item 1: Tag Number/Area Prefix – Lists the tag number and area number (if applicable) of every instrument.

Item 2: Service – Describes the type of process where the instrument is installed and/or how the instrument functions in terms of measuring the process.

ITEM 1	ITEM 2	ITEM 3A	ITEM 4	ITEM 5	ITEM 6						ITEM 7	
AREA PREFIX	SERVICE	LOCATION	MFR	SPEC SHEET NO.	P & I DWG NO.	LOOP-SHEET DWG NO.	LOCATION & ROUTING DRAWING NO.	INSTL DETAIL DWG NO.	PIPING DWG NO.	ELECT DWG NO.	VENDOR DWG NO.	NOTES
TAG NO.												
LAH-1	Cooling Tower Level	PV	ACME	03-LA-1	03-P-100	03-L-1	-----	-----	-----	-----	-----	P.O. NO. 249-126
LAL-1	Cooling Tower Level	PV	ACME	03-LA-1	03-P-100	03-L-1	-----	-----	-----	-----	-----	P.O. NO. 249-126
LIC-1	Cooling Tower Level	L	Jones	03-C-2	03-P-100	03-L-1	03-I-600	65-I-502	-----	-----	-----	P.O. NO. 249-290
LSH-1	Cooling Tower Level	L	US Inst.	03-LS-1	03-P-100	03-L-1	03-I-600	-----	-----	-----	-----	P.O. NO. 249-423
LT-1	Cooling Tower Level	F	Smith	03-LT-1	03-P-100	03-L-1	03-I-600	03-I-600	03-P-200	-----	-----	P.O. NO. 249-612
LV-1	Cooling Tower Level	F	Honey	0V-V-2	03-P-100	03-L-1	03-I-600	65-I-523	03-P-200	-----	-----	P.O. NO. 249-612
PC-1	Cooling Tower Recirculation Water Pressure	F	Fisher	03-V-005	03-P-100	03-P-002	03-I-600	65-I-502 65-I-540 A	03-P-200	-----	-----	P.O. NO. 249-083
PCV-2	Cooling Tower Recirculation Water Pressure	F	Fisher	03-V-005	03-P-100	03-P-002	03-I-600	65-I-524	03-P-200	-----	-----	P.O. NO. 249-083
VAH-3A	Cooling Tower Fan Vibration	PV	Roberts	03-VA-1	03-P-100	66-I-301	-----	-----	-----	-----	-----	P.O. NO. 249-016
VT-3A	Cooling Tower Fan Vibration	PV	Roberts	03-VA-1	03-P-100	03-V-003	03-I-600	-----	-----	-----	-----	P.O. NO. 249-016
VAH-3B	Cooling Tower Fan Vibration	PV	Roberts	03-VT-1	03-P-100	66-I-301	-----	-----	-----	-----	-----	P.O. NO. 249-018
VT-3B	Cooling Tower Fan Vibration	PV	Roberts	03-VS-1	03-P-100	03-V-003	03-I-600	-----	-----	-----	-----	P.O. NO. 249-018
				LOCATION LEGEND			DRAWN BY: WORD PROCESS.	DATE 4/26/92	A B & C ENGINEERING			NO. 2 COOLING TOWER
				A - ANALOG SOFTWARE B - BACK OF PANEL D - DIGITAL SOFTWARE E - EXISTING F - FIELD L - LOCAL PANEL P - FRONT OF PANEL B - BACK V - VENDOR PACKAGE	DESIGNED BY	DATE 3/29/92				CONTRAC T NO. ABC-249	SHEET 1 OF 3	INSTRU MENT INDEX
1	8/5/92	ADDED HEAT TRACE I.D.			CHECKED BY	DATE 5/05/92						
0	5/7/92	RELEASED FOR CONSTRUCTION			APPROVED BY	DATE						
NO.	DATE	REVISIONS	DSGN		RELEASED BY	DATE 5/07/92						

Figure 70. Instrument Index

Items 3A & 3B: Location/Location Legend – The location where the instrument is installed is often represented as a letter or several letters. The legend at the bottom of the index indicates the meaning of the location letters.

Item 4: Manufacturer – Lists the manufacturer of the instrument. A technician needs to know the manufacturer of an instrument to request specifications and order new parts.

Item 5: Specification Sheet Number – Lists the specification sheet number of the instrument. These sheets detail the physical characteristics of the instrument.

Item 6: Drawing Numbers – An instrument can list several types of drawings for an instrument. These include:

- P&I Drawing Number – lists the piping and instrument drawing number on which the instrument appears.
- Loop Sheet Drawing Number – lists the loop drawing number on which the instrument appears.
- Location & Routing Drawing Number – lists the location or panel drawing number on which the instrument appears.
- Installation Detail Drawing Number – lists the installation drawing number on which the instrument appears. These drawings describe how to install the instrument.
- Piping Drawing Number – these drawings show the piping line where the instrument is installed.
- Electrical Drawing Number – these drawings show the electrical connections of the instrument.
- Vendor Drawing Number – lists any vendor drawings that relate to the instrument.

Item 7: Notes – Lists any additional information about the instrument (e.g. purchase order number).

Item 8: Revisions – List any revisions made to the instrument index. This includes when and by whom.

Item 9: Signoffs – List several signoffs on the instrument index to ensure accuracy.

Item 10: Additional Information – This section can contain a variety of extra information (e.g. the name of the company that created the instrument index, sheet number, etc.)

Procedure Overview

In this procedure, you will examine an instrument index for the T5552 Process Control System. You will use the instrument index to determine as much information as possible about various devices on the T5552.



- 1. Examine the partial instrument index for the T5552, as shown in figure 71.

T5552 PROCESS CONTROL TRAINER INSTRUMENT INDEX							
DRAWING NO. A010618-1 INST							
TAG NO.	SERVICE	LOCATION	MFR.	MFR. PART NO.	DESCRIPTION	SPEC SHEET NO.	P&ID DWG NO.
FCV-100	Process Liquid Flow		Robertshaw	1/2-VC210B-BL	Proportional Flow Control Valve		A010618-1 P&ID
FE-100	Process Liquid Flow		GF Signet	3-2000-21	Paddlewheel Flow Element, 0.3-3.2 GPM		A010618-1 P&ID
FE-100A	Process Liquid Flow		Dieterich-Standard	DNT+10S005H9900C0000	Pitot Tube Flow Element		A010618-1 P&ID
FE-100B	Process Liquid Flow		Preso	VBR50NN-10	Venturi Flow Element, 0.25-1.3 GPM		A010618-1 P&ID
FE-100C	Process Liquid Flow		Amatrol	A010618-41	Orifice Plate Flow Element Assy		A010618-1 P&ID
FI-100	Process Liquid Flow		Dwyer	VFB-85-EC-PF	Var. Area Flow Indicator, 0.2-2 GPM		A010618-1 P&ID
FIT-100	Process Liquid Flow		GF Signet	3-8550-1P	Flow Indicating Transmitter		A010618-1 P&ID
FV-100	Process Liquid Flow		George Fischer	161.325.522	Manual Flow Control Valve		A010618-1 P&ID
HV-100A	Process Liquid Flow		Colonial	V07191N	Hand Valve		A010618-1 P&ID
HV-100B	Process Liquid Flow		Colonial	V07191N	Hand Valve		A010618-1 P&ID
HV-100C	Process Liquid Flow		Colonial	V07191N	Hand Valve		A010618-1 P&ID
IY-100	Process Liquid Flow		Dwyer	IP-42	Current-to-Pressure Transducer		A010618-1 P&ID
PC-100	Process Liquid Flow		SMC	NAR11102X247	Air Pressure Regulator		A010618-1 P&ID
PI-100A	Process Liquid Flow		SMC	KA50-MP0.2N02MS	Pressure Gauge, 0-30 PSIG		A010618-1 P&ID
PI-100B	Process Liquid Flow		SMC	KA50-MP0.2N02MS	Pressure Gauge, 0-30 PSIG		A010618-1 P&ID
PI-100C	Process Liquid Flow		SMC	K50-MP0.4-N02S	Pressure Gauge, 0-60 PSIG		A010618-1 P&ID
PI-100D	Process Liquid Flow		SMC	K50-MP0.2N02MS	Pressure Gauge, 0-30 PSIG		A010618-1 P&ID
PU-100	Process Liquid Flow		Beckett	G600A	Submersible Centrifugal Pump		A010618-1 P&ID
SV-100A	Process Liquid Flow		ASCO	8210G94-120VAC	Solenoid Valve, 4 Cv		A010618-1 P&ID
SV-100B	Process Liquid Flow		ASCO	8263G200-120VAC	Solenoid Valve, 0.52 Cv		A010618-1 P&ID
SV-100C	Process Liquid Flow		ASCO	8263G210-120VAC	Solenoid Valve, 0.85 Cv		A010618-1 P&ID
LET-200A	Process Tank Liquid Level		Dwyer	673-1	Head Pressure Level Transmitter, 1 PSIG		A010618-1 P&ID
LET-200B	Process Tank Liquid Level		Migmatron	RPS-401A-40	Ultrasonic Level Sensor		A010618-1 P&ID
LSH-200A	Process Tank Liquid Level		Amatrol	A010618-10	Float Type Level Switch		A010618-1 P&ID
LSH-200B	Process Tank Liquid Level		Amatrol	A010618-10	Float Type Level Switch		A010618-1 P&ID
F1-100A/LI-200	Process Flow/Tank Level		Honeywell	DI1703110010000	Digital Process Meter		A010618-1 P&ID
FIC-100/LIC-200	Process Flow/Tank Level		Honeywell	DC3500-0E-3B00-200-00000-00-0	Digital PID Controller		A010618-1 P&ID
FIT-100A/LIT-200	Process Flow/Tank Level		Rosemount	3051CD1A52A1AM5	Diff. Press. Flow Transmitter, 0-25 In. Water		A010618-1 P&ID
HV-300	Process Tank Compartment B		Colonial	V07191N	Hand Valve		A010618-1 P&ID
HV-400	Process Tank Drain		Colonial	V07191N	Hand Valve		A010618-1 P&ID

Figure 71. Partial Instrument Index for the T5552

- 2. Locate the device with a tag number of IY-100.
- 3. Determine the following information for the selected device.

Service _____

Manufacturer _____

Part Number _____

Description _____

The device is part of the process liquid flow loop (service). The manufacturer of the device is Dwyer. The part number is IP-42. The description of the device is an I/P (current-to-pneumatic) converter.

- 4. Locate the device with a tag number of FE-100 on the instrument index. Record the information for the device.

Service _____

Manufacturer _____

Part Number _____

Description _____

- 5. Locate the device with a tag number of SV-100A on the instrument index. Record the information for the device.

Service _____

Manufacturer _____

Part Number _____

Description _____

6. Locate the device with a tag number of PI-100A on the instrument index. Record the information for the device.

Service _____

Manufacturer _____

Part Number _____

Description _____

7. Locate the device with a tag number of SV-100C on the instrument index. Record the information for the device.

Service _____

Manufacturer _____

Part Number _____

Description _____

8. Repeat step 7 for the devices listed in the following table.

DEVICE TAG NO.	SERVICE	MANUFACTURER	PART NO.	DESC.
LSH-200A				
LET-200A				
FIT-100				
FI-100				
LET-200B				
HV-300				



1. A(n) _____ is a document that lists every instrument in the process by tag number.
2. It is important to know the _____ of an instrument in case you need specifications on it or need to order a new one.
3. The _____ data in an instrument index describes the type of process where the instrument is installed.
4. A location legend is sometimes included at the _____ of an instrument index.
5. The _____ number indicates on which document information about the physical characteristics of the instrument can be found.

