Introduction

Control in process industries refers to the regulation of all aspects of the process. Precise control of level, temperature, pressure and flow is important in many process applications. This module introduces you to control in process industries, explains why control is important, and identifies different ways in which precise control is ensured.

The Importance of Process Control

Refining, combining, handling, and otherwise manipulating fluids to profitably produce end products can be a precise, demanding, and potentially hazardous process. Small changes in a process can have a large impact on the end result. Variations in proportions, temperature, flow, turbulence, and many other factors must be carefully and consistently controlled to produce the desired end product with a minimum of raw materials and energy. Process control technology is the tool that enables manufacturers to keep their operations running within specified limits and to set more precise limits to maximize profitability, ensure quality and safety.

The Importance of Process Control

PROCESS

Process as used in the terms *process control* and *process industry,* refers to the methods of changing or refining raw materials to create end products. The raw materials, which either pass through or remain in a liquid, gaseous, or slurry (a mix of solids and liquids) state during the process, are transferred, measured, mixed, heated or cooled, filtered, stored, or handled in some other way to produce the end product.

Process industries include the chemical industry, the oil and gas industry, the food and beverage industry, the pharmaceutical industry, the water treatment industry, and the power industry.

PROCESS CONTROL

Process control refers to the methods that are used to control process variables when manufacturing a product. For example, factors such as the proportion of one ingredient to another, the temperature of the materials, how well the ingredients are mixed, and the pressure under which the materials are held can significantly impact the quality of an end product. Manufacturers control the production process for three reasons:

- ❑ Reduce variability
- ❑ Increase efficiency
- ❑ Ensure safety

Reduce Variability

Process control can reduce variability in the end product, which ensures a consistently high-quality product. Manufacturers can also save money by reducing variability. For example, in a gasoline blending process, as many as 12 or more different components may be blended to make a specific grade of gasoline. If the refinery does not have precise control over the flow of the separate components, the gasoline may get too much of the high-octane components. As a result, customers would receive a higher grade and more expensive gasoline than they paid for, and the refinery would lose money. The opposite situation would be customers receiving a lower grade at a higher price.

Activities

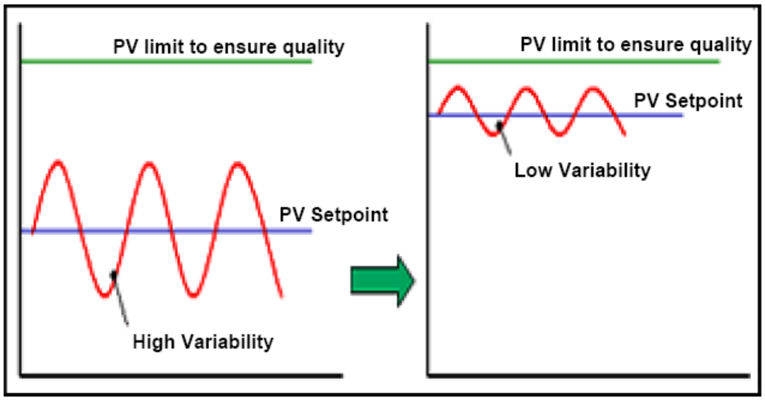
1. Process is defined as the changing or refining of raw materials that pass through or remain in a liquid, gaseous, or slurry state to to create end products.

2. Which of these industries are examples of the process industry?
   Select all options that apply.

1 Pharmaceutical
2 Satellite
3 Oil and Gas
4 Cement
5 Power

The Importance of Process Control

Reducing variability can also save money by reducing the need for product padding to meet required product specifications. *Padding* refers to the process of making a product of higher-quality than it needs to be to meet specifications. When there is variability in the end product (i.e., when process control is poor), manufacturers are forced to pad the product to ensure that specifications are met, which adds to the cost. With accurate, dependable process control, the *setpoint* (desired or optimal point) can be moved closer to the actual product specification and thus save the manufacturer money.



Increase Efficiency

Some processes need to be maintained at a specific point to maximize efficiency. For example, a control point might be the temperature at which a chemical reaction takes place. Accurate control of temperature ensures process efficiency. Manufacturers save money by minimizing the resources required to produce the end product.

Ensure Safety

A run-away process, such as an out-of-control nuclear or chemical reaction, may result if manufacturers do not maintain precise control of all of the processg variables. The consequences of a run-away process can be catastrophic.

Activities

3. What are the main reasons for manufacturers to control a process? Select all options that apply.

1 Reduce variability
2 Ensure safety
3 Reduce costs
4 Increase efficiency
5 Increase productivity

Precise process control may also be required to ensure safety. For example, maintaining proper boiler pressure by controlling the inflow of air used in combustion and the outflow of exhaust gases is crucial in preventing boiler implosions that can clearly threaten the safety of workers.

The Control Loop

Imagine you are sitting in a cabin in front of a small fire on a cold winter evening. You feel uncomfortably cold, so you throw another log on the fire. This is an example of a *control loop*. In the control loop, a variable (temperature) fell below the setpoint (your comfort level), and you took action to bring the process back into the desired condition by adding fuel to the fire. The control loop will now remain static until the temperature again rises above or falls below your comfort level.

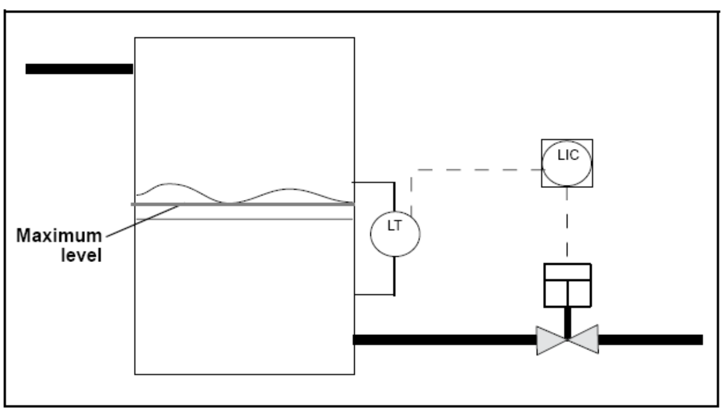
THREE TASKS

Control loops in the process control industry work in the same way, requiring three tasks to occur:

- ❑ Measurement
- ❑ Comparison
- ❑ Adjustment

In Figure 7.1, a level transmitter (LT) measures the level in the tank and transmits a signal associated with the level reading to a controller (LIC). The controller compares the reading to a predetermined value, in this case, the maximum tank level established by the plant operator, and finds that the values are equal. The controller then sends a signal to the device that can bring the tank level back to a lower level—a valve at the bottom of the tank. The valve opens to let some liquid out of the tank.

Many different instruments and devices may or may not be used in control loops (e.g., transmitters, sensors, controllers, valves, pumps), but the three tasks of measurement, comparison, and adjustment are always present.



A Simple Control Loop

Activities

1. The three tasks associated with any control loop are measurement, comparison, and adjustment. Is this statement true or false?

Process Control Terms

As in any field, process control has its own set of common terms that you should be familiar with and that you will use when talking about control technology.

PROCESS VARIABLE

A *process variable* is a condition of the process fluid (a liquid or gas) that can change the manufacturing process in some way. In the example of you sitting by the fire, the process variable was temperature. In the example of the tank in Figure 7.1, the process variable is level. Common process variables include:

- ❑ Pressure
- ❑ Flow
- ❑ Level
- ❑ Temperature
- ❑ Density
- ❑ Ph (acidity or alkalinity)
- ❑ Liquid interface (the relative amounts of different liquids that are combined in a vessel)
- ❑ Mass
- ❑ Conductivity

SETPOINT

The *setpoint* is a value for a process variable that is desired to be maintained. For example, if a process temperature needs to kept within 5 °C of 100 °C, then the setpoint is 100 °C. A temperature sensor can be used to help maintain the temperature at setpoint.
The sensor is inserted into the process, and a contoller compares the temperature reading from the sensor to the setpoint. If the temperature reading is 110 °C, then the controller determines that the process is above setpoint and signals the fuel valve of the burner to close slightly until the process cools to 100 °C. Set points can also be maximum or minimum values. For example, level in tank cannot exceed 20 feet.

Activities

2. A process variable is a condition that can change the process in some way.

3. Imagine you are in a cabin in front of a small fire on a cold winter evening. You feel uncomfortably cold, so you throw another log into the fire. In this scenario, the process variable is temperature. Is this true or false?

4. If the level of a liquid in a tank must be maintained within 5 ft of 50 ft, what is the liquid's setpoint?

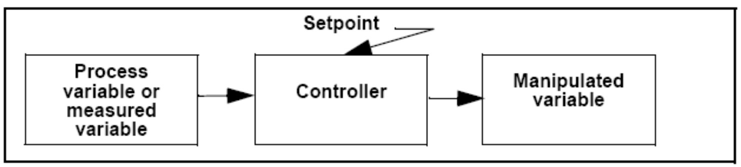
1 45 ft
2 55 ft
3 5 ft
4 50 ft

Process Control Terms

MEASURED VARIABLES, PROCESS VARIABLES, AND MANIPULATED VARIABLES

In the temperature control loop example, the measured variable is temperature, which must be held close to 100 °C. In this example and in most instances, the measured variable is also the process variable. The *measured variable* is the condition of the process fluid that must be kept at the designated setpoint.

Sometimes the measured variable is not the same as the process variable. For example, a manufacturer may measure flow into and out of a storage tank to determine tank level. In this scenario, flow is the measured variable, and the process fluid level is the *process variable*. The factor that is changed to keep the measured variable at setpoint is called the *manipulated variable*. In the example described, the manipulated variable would also be flow (Figure 7.2).



Variables

ERROR

Error is the difference between the measured variable and the setpoint and can be either positive or negative. In the temperature control loop example, the error is the difference between the 110 °C measured variable and the 100 °C setpoint—that is, the error is +10 °C.

The objective of any control scheme is to minimize or eliminate error. Therefore, it is imperative that error be well understood. Any error can be seen as having three major components. These three components are shown in the figure on the folowing page

Magnitude

The magnitude of the error is simply the deviation between the values of the setpoint and the process variable. The magnitude of error at any point in time compared to the previous error provides the basis for determining the change in error. The change in error is also an important value.

Activities

5. ____________________ is a sustained deviation of the process variable from the setpoint.

6. A load disturbance is an undesired change in one of the factors that can affect the setpoint. Is this statement true or false?

Process Control Terms

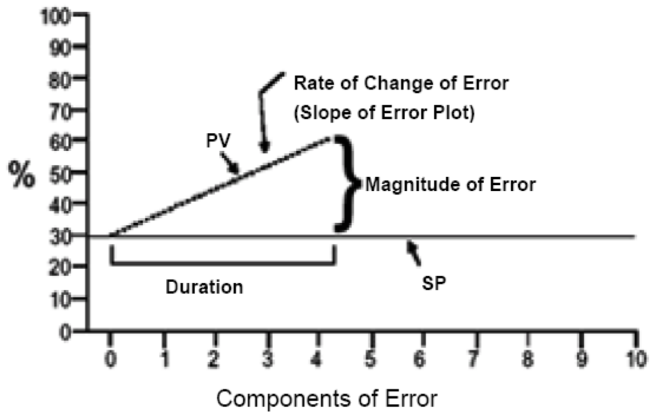
Activities

Duration

Duration refers to the length of time that an error condition has existed.

Rate Of Change

The rate of change is shown by the slope of the error plot.



OFFSET

Offset is a sustained deviation of the process variable from the setpoint. In the temperature control loop example, if the control system held the process fluid at 100.5 °C consistently, even though the setpoint is 100 °C, then an offset of 0.5 °C exists.

LOAD DISTURBANCE

A *load disturbance* is an undesired change in one of the factors that can affect the process variable. In the temperature control loop example, adding cold process fluid to the vessel would be a load disturbance because it would lower the temperature of the process fluid.

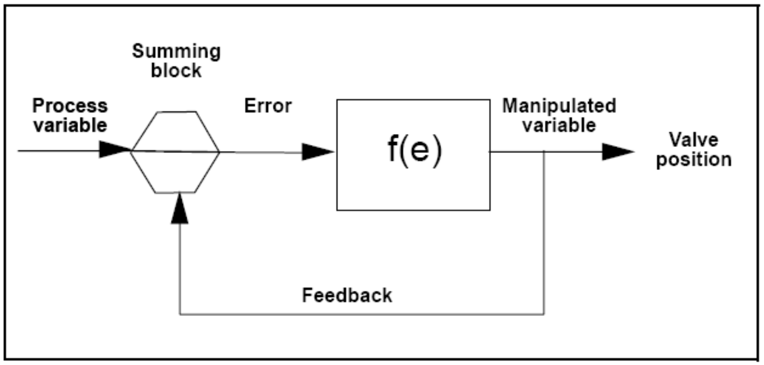
CONTROL ALGORITHM

A *control algorithm* is a mathematical expression of a control function. Using the temperature control loop example, V in the equation below is the fuel valve position, and e is the error. The relationship in a control algorithm can be expressed as:

Process Control Terms

$$V = f(\pm e)$$

The fuel valve position (V) is a function (f) of the sign (positive or negative) of the error (Figure 7.3).



Algorithm Example

Control algorithms can be used to calculate the requirements of much more complex control loops than the one described here. In more complex control loops, questions such as "How far should the valve be opened or closed in response to a given change in setpoint?" and "How long should the valve be held in the new position after the process variable moves back toward setpoint?" need to be answered.

MANUAL AND AUTOMATIC CONTROL

Before process automation, people, rather than machines, performed many of the process control tasks. For example, a human operator might have watched a level gauge and closed a valve when the level reached the setpoint. Control operations that involve human action to make an adjustment are called *manual control* systems. Conversely, control operations in which no human intervention is required, such as an automatic valve actuator that responds to a level controller, are called *automatic control* systems.

Activities

7. Automatic control systems are control operations that involve human action to make adjustment. Is this statement true or false?

Process Control Terms

CLOSED AND OPEN CONTROL LOOPS

A *closed control loop* exists where a process variable is measured, compared to a setpoint, and action is taken to correct any deviation from setpoint. An *open control loop* exists where the process variable is not compared, and action is taken not in response to feedback on the condition of the process variable, but is instead taken without regard to process variable conditions. For example, a water valve may be opened to add cooling water to a process to prevent the process fluid from getting too hot, based on a pre-set time interval, regardless of the actual temperature of the process fluid.

Activities

8. Under what circumstances does an open control loop exist?
   Select all options that apply.

1 Process variable is not measured
2 Process variable is not compared
3 Process variable is measured and compared to a setpoint
4 Action is taken without regard to process variable conditions
5 Action is taken with regard to process variable conditions

Control Loop Equipment and Technology

The previous section described the basic elements of control as measurement, comparison, and adjustment. In practice, there are instruments and strategies to accomplish each of these essential tasks. In some cases, a single process control instrument, such as a modern pressure transmitter, may perform more than one of the basic control functions. Other technologies have been developed so that communication can occur among the components that measure, compare, and adjust.

PRIMARY ELEMENTS/SENSORS

In all cases, some kind of instrument is measuring changes in the process and reporting a process variable measurement. Some of the greatest ingenuity in the process control field is apparent in sensing devices. Because sensing devices are the first element in the control loop to measure the process variable, they are also called *primary elements*. Examples of primary elements include:

- ❑ Pressure sensing diaphragms, strain gauges, capacitance cells
- ❑ Resistance temperature detectors (RTDs)
- ❑ Thermocouples
- ❑ Orifice plates
- ❑ Pitot tubes
- ❑ Venturi tubes
- ❑ Magnetic flow tubes
- ❑ Coriolis flow tubes
- ❑ Radar emitters and receivers
- ❑ Ultrasonic emitters and receivers
- ❑ Annubar flow elements
- ❑ Vortex sheddar

Primary elements are devices that cause some change in their property with changes in process fluid conditions that can then be measured. For example, when a conductive fluid passes through the magnetic field in a magnetic flow tube, the fluid generates a voltage that is directly proportional to the velocity of the process fluid. The primary element (magnetic flow tube) outputs a voltage that can be measured and used to calculate the fluid's flow rate. With an RTD, as the temperature of a process fluid surrounding the RTD rises or falls, the electrical resistance of the RTD increases or decreases a proportional amount. The resistance is measured, and from this measurement, temperature is determined.

Activities

1. Identify three examples of a primary element/sensors in process control?
   Select all options that apply.

   1 Resistance Temperature Detectors
   2 Thermocouples
   3 Control Valve
   4 Converter
   5 Pitot tubes

2. Primary elements will not make direct contact with the process fluid. Is this statement true or false?

Control Loop Equipment and Technology

TRANSDUCERS AND CONVERTERS

A *transducer* is a device that translates a mechanical signal into an electrical signal. For example, inside a capacitance pressure device, a transducer converts changes in pressure into a proportional change in capacitance.

A *converter* is a device that converts one type of signal into another type of signal. For example, a converter may convert current into voltage or an analog signal into a digital signal. In process control, a converter used to convert a 4–20 mA current signal into a 3–15 psig pneumatic signal (commonly used by valve actuators) is called a *current-to-pressure converter*.

TRANSMITTERS

A *transmitter* is a device that converts a reading from a sensor or transducer into a standard signal and transmits that signal to a monitor or controller. Transmitter types include:

- ❑ Pressure transmitters
- ❑ Flow transmitters
- ❑ Temperature transmitters
- ❑ Level transmitters
- ❑ Analytic (O_2 [oxygen], CO [carbon monoxide], and pH) transmitters

Activities

3. A ____________ is a device that translates a mechanical signal into an electrical signal.

4. A transmitter is a device that converts a reading from a transducer into a standard signal and transmits that signal to a monitor or controller. Is this statement true or false?

Control Loop Equipment and Technology

SIGNALS

There are three kinds of signals that exist for the process industry to transmit the process variable measurement from the instrument to a centralized control system.

1. Pneumatic signal
2. Analog signal
3. Digital signal

Pneumatic Signals

Pneumatic signals are signals produced by changing the air pressure in a signal pipe in proportion to the measured change in a process variable. The common industry standard pneumatic signal range is 3–15 psig. The 3 corresponds to the lower range value (LRV) and the 15 corresponds to the upper range value (URV). Pneumatic signalling is still common. However, since the advent of electronic instruments in the 1960s, the lower costs involved in running electrical signal wire through a plant as opposed to running pressurized air tubes has made pneumatic signal technology less attractive.

Analog Signals

The most common standard electrical signal is the 4–20 mA current signal. With this signal, a transmitter sends a small current through a set of wires. The current signal is a kind of gauge in which 4 mA represents the lowest possible measurement, or zero, and 20 mA represents the highest possible measurement.

For example, imagine a process that must be maintained at 100 °C. An RTD temperature sensor and transmitter are installed in the process vessel, and the transmitter is set to produce a 4 mA signal when the process temperature is at 95 °C and a 20 mA signal when the process temperature is at 105 °C. The transmitter will transmit a 12 mA signal when the temperature is at the 100 °C setpoint. As the sensor's resistance property changes in response to changes in temperature, the transmitter outputs a 4–20 mA signal that is proportionate to the temperature changes. This signal can be converted to a temperature reading or an input to a control device, such as a burner fuel valve.

Other common standard electrical signals include the 1–5 V (volts) signal and the pulse output.

Activities

5. Identify the signal types that are used in the process control industry?
   Select all options that apply.

1. Hydraulic signals
2. Digital signals
3. Analog signals
4. Pneumatic signals
5. Electro-magnetic signals

Control Loop Equipment and Technology

Digital Signals

Digital signals are the most recent addition to process control signal technology. Digital signals are discrete levels or values that are combined in specific ways to represent process variables and also carry other information, such as diagnostic information. The methodology used to combine the digital signals is referred to as protocol.

Manufacturers may use either an open or a proprietary digital protocol. Open protocols are those that anyone who is developing a control device can use. Proprietary protocols are owned by specific companies and may be used only with their permission. Open digital protocols include the HART® (highway addressable remote transducer) protocol, FOUNDATION™ Fieldbus, Profibus, DeviceNet, and the Modbus® protocol.

(See *Module 8: Communication Technologies* for more information on digital communication protocols.)

INDICATORS

While most instruments are connected to a control system, operators sometimes need to check a measurement on the factory floor at the measurement point. An indictor makes this reading possible. An *indicator* is a human-readable device that displays information about the process. Indicators may be as simple as a pressure or temperature gauge or more complex, such as a digital read-out device. Some indicators simply display the measured variable, while others have control buttons that enable operators to change settings in the field.

Activities

6. The ___________ is a human-readable device that displays information about the process or the instrument it is connected to.

7. Which of the following are examples of a digital signal?
   Select all options that apply.

1 Profibus
2 4 - 20 mA
3 1 - 5 v
4 Fieldbus
5 3 - 15 psig

Control Loop Equipment and Technology

RECORDERS

A *recorder* is a device that records the output of a measurement devices. Many process manufacturers are required by law to provide a process history to regulatory agencies, and manufacturers use recorders to help meet these regulatory requirements. In addition, manufacturers often use recorders to gather data for trend analyses. By recording the readings of critical measurement points and comparing those readings over time with the results of the process, the process can be improved.

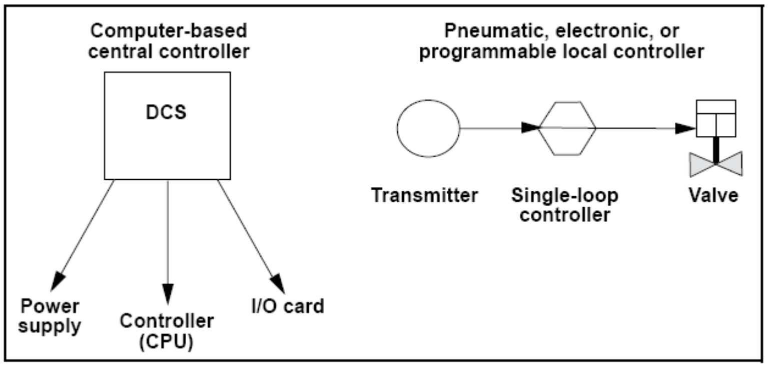
Different recorders display the data they collect differently. Some recorders list a set of readings and the times the readings were taken; others create a chart or graph of the readings. Recorders that create charts or graphs are called *chart recorders*.

Activities

8. A recorder is a device that records the _________________ of a measurement or control device.

CONTROLLERS

A *controller* is a device that receives data from a measurement instrument, compares that data to a programmed setpoint, and, if necessary, signals a control element to take corrective action. *Local controllers* are usually one of the three types: pneumatic, electronic or programmable. Contollers also commonly reside in a digital control system.

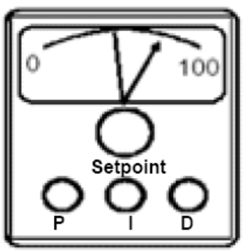


Controllers

Control Loop Equipment and Technology

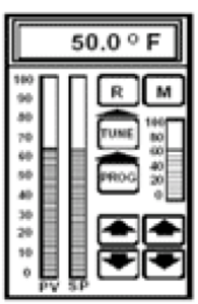
Controllers may perform complex mathematical functions to compare a set of data to setpoint or they may perform simple addition or subtraction functions to make comparisons. Controllers always have an ability to receive input, to perform a mathematical function with the input, and to produce an output signal. Common examples of controllers include:

- *Programmable logic controllers* (PLCs)—PLCs are usually computers connected to a set of input/output (I/O) devices. The computers are programmed to respond to inputs by sending outputs to maintain all processes at setpoint.
- *Distributed control systems* (DCSs)—DCSs are controllers that, in addition to performing control functions, provide readings of the status of the process, maintain databases and advanced man-machine-interface.



Pipestand Controller
(Pneumatic or Electronic)

Analog Rack Mount Controller
(Electronic)



Single Loop Digital Converter
(Electronic)

Distributed Control System
(Electronic)

Types of Process Controllers

Activities

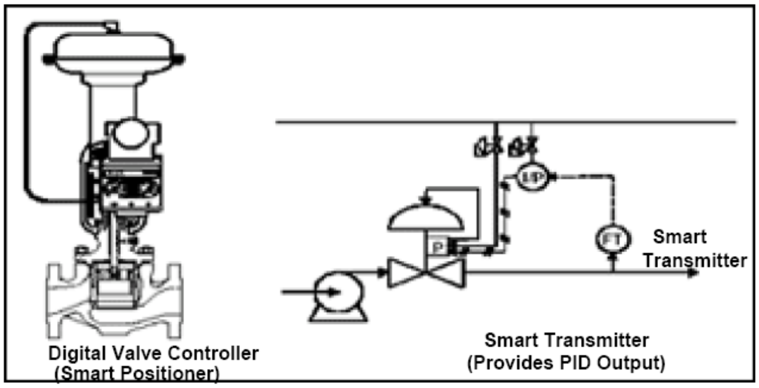
9. Which of the following have the ability to receive input, to perform a mathematical function with the input, and produce an output signal?

1 Actuators
2 Transmitters
3 Transducers
4 Controllers

10. Which of the following is the most common final control element in process control industries?

1 Agitator
2 Pump motor
3 Valve
4 Louver

Control Loop Equipment and Technology



Types of Process Controllers

CORRECTING ELEMENTS/FINAL CONTROL ELEMENTS

The *correcting* or *final control element* is the part of the control system that acts to physically change the manipulated variable. In most cases, the final control element is a valve used to restrict or cut off fluid flow, but pump motors, louvers (typically used to regulate air flow), solenoids, and other devices can also be final control elements.

Final control elements are typically used to increase or decrease fluid flow. For example, a final control element may regulate the flow of fuel to a burner to control temperature, the flow of a catalyst into a reactor to control a chemical reaction, or the flow of air into a boiler to control boiler combustion.

In any control loop, the speed with which a final control element reacts to correct a variable that is out of setpoint is very important. Many of the technological improvements in final control elements are related to improving their response time.

ACTUATORS

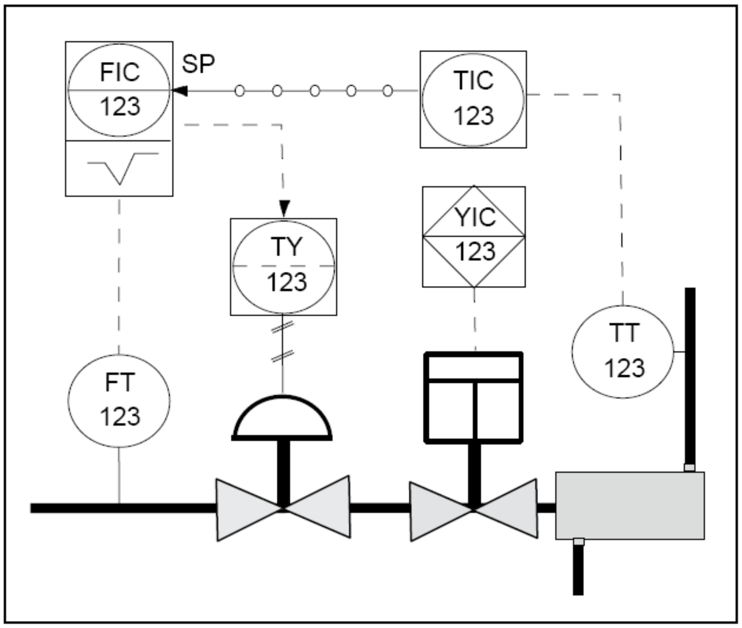
An *actuator* is the part of a final control device that causes a physical change in the final control device when signalled to do so. The most common example of an actuator is a valve actuator, which opens or closes a valve in response to control signals from a controller. Actuators are often powered pneumatically, hydraulically, or electrically. Diaphragms, bellows, springs, gears, hydraulic pilot valves, pistons, or electric motors are often parts of an actuator system.

Activities

11. _______________ is a part final control device that causes a physical change in the final control device when signaled to do so.

ISA Symbology

The Instrumentation, Systems, and Automation Society (ISA) is one of the leading process control trade and standards organizations. The ISA has developed a set of symbols for use in engineering drawings and designs of control loops (ISA S5.1 instrumentation symbol specification). You should be familiar with ISA symbology so that you can demonstrate possible process control loop solutions on paper to your customer. Figure 7.5 shows a control loop using ISA symbology. Drawings of this kind are known as *piping and instrumentation drawings* (P&ID).



Piping and Instrumentation Drawing
(P&ID)

Activities

12. What does the acronym P&ID stand for?

1. Piping and Instrument Designing
2. Piping and Instrumentation Drawing
3. Process Control and Installation Drawing
4. Proportional, Intergral and Derivative control

ISA Symbology

SYMBOLS

In a P&ID, a circle represents individual measurement instruments, such as transmitters, sensors, and detectors (Figure 7.6).

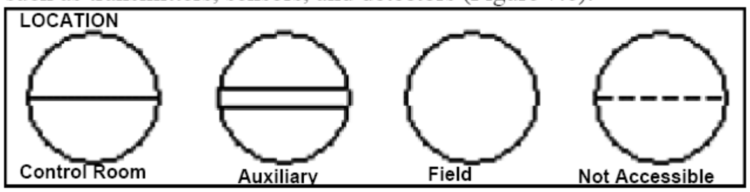
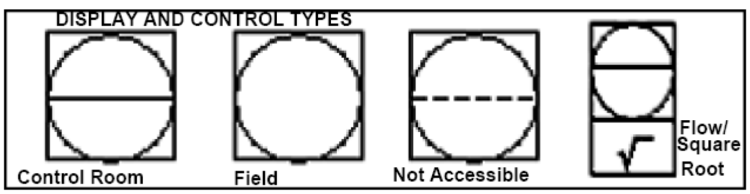


Figure 7.6: Discrete Instruments

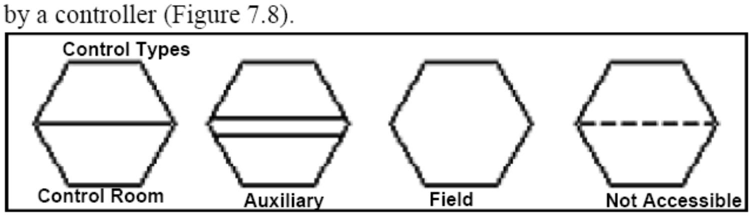
A single horizontal line running across the center of the shape indicates that the instrument or function is located in a primary location (e.g., a control room). A double line indicates that the function is in an auxiliary location (e.g., an instrument rack). The absence of a line indicates that the function is field mounted, and a dotted line indicates that the function or instrument is inaccessible (e.g., located behind a panel board).

A square with a circle inside represents instruments that both display measurement readings and perform some control function (Figure 7.7). Many modern transmitters are equipped with microprocessors that perform control calculations and send control output signals to final control elements.



Shared Control/Display Elements

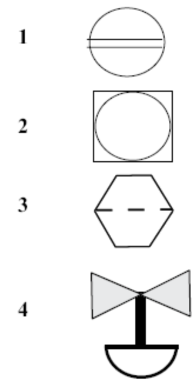
A hexagon represents computer functions, such as those carried out by a controller (Figure 7.8).



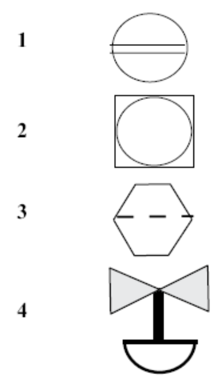
Computer Functions (Controllers)

Activities

13. Which of the following is a symbol of a transmitter in an auxiliary location?

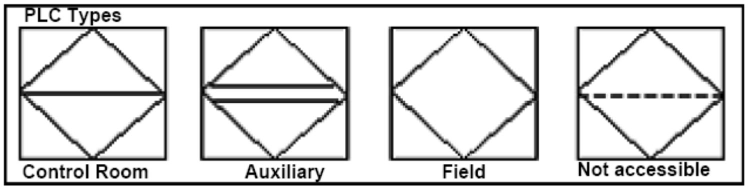


14. Which of the following is a symbol of a field-mounted control/display element?



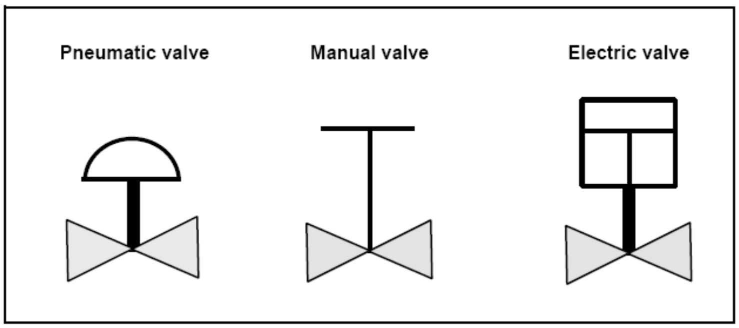
ISA Symbology

A square with a diamond inside represents PLCs (Figure 7.9).



PLCs

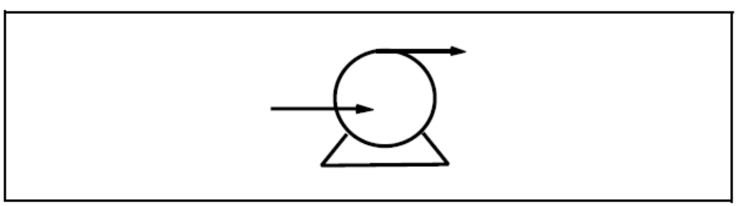
Two triangles with their apexes contacting each other (a "bow tie" shape) represent a valve in the piping. An actuator is always drawn above the valve (Figure 7.10).



Valves

Pumps

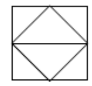
Directional arrows showing the flow direction represent a pump (Figure 7.11).



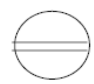
Pumps

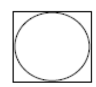
Activities

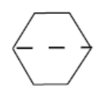
16. The symbol displayed below denotes a PLC in a primary location. Is this statement true or false?

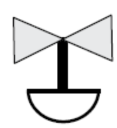


17. Which of the following is a symbol of a pneumatic valve?

1 

2 

3 

4 

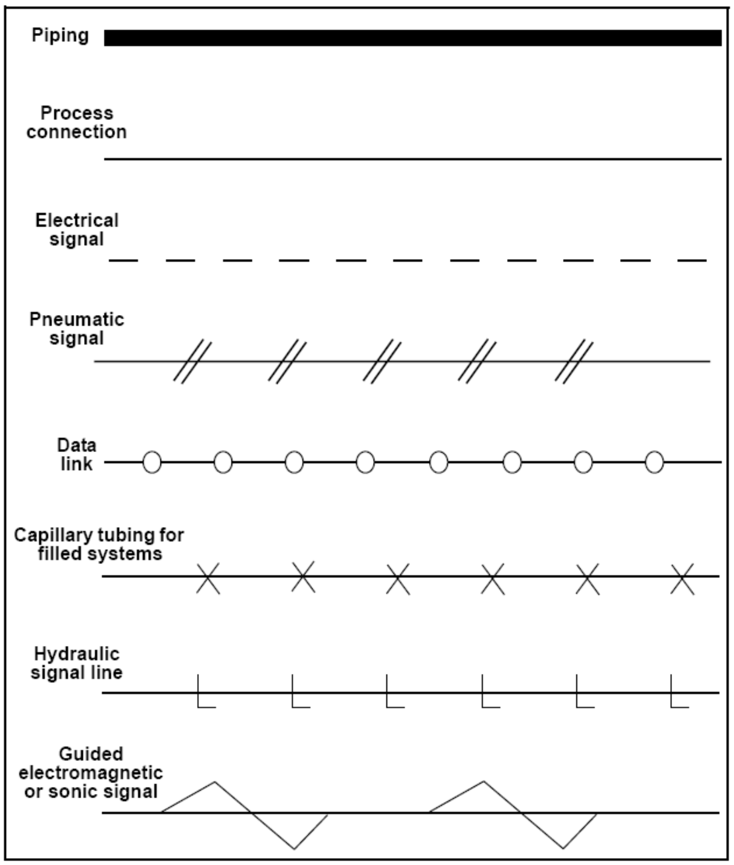
ISA Symbology

Piping and Connections

Piping and connections are represented with several different symbols (Figure 7.12):

- A heavy solid line represents piping
- A thin solid line represents process connections to instruments (e.g., impulse piping)
- A dashed line represents electrical signals (e.g., 4–20 mA connections)
- A slashed line represents pneumatic signal tubes
- A line with circles on it represents data links

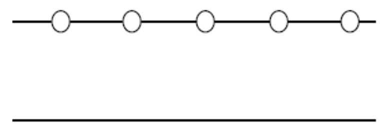
Other connection symbols include capillary tubing for filled systems (e.g., remote diaphragm seals), hydraulic signal lines, and guided electromagnetic or sonic signals.



Piping and Connection Symbols

Activities

18. The symbols displayed below represent a data link and a process connection. Is this statement true or false?



ISA Symbology

Identification Letters

Identification letters on the ISA symbols (e.g., TT for temperature transmitter) indicate:

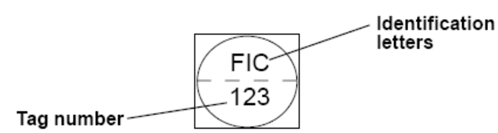
- ❑ The variable being measured (e.g., flow, pressure, temperature)
- ❑ The device's function (e.g., transmitter, switch, valve, sensor, indicator)
- ❑ Some modifiers (e.g., high, low, multifunction)

Table 7.1 on page 26 shows the ISA identification letter designations. The initial letter indicates the measured variable. The second letter indicates a modifier, readout, or device function. The third letter usually indicates either a device function or a modifier.

For example, "FIC" on an instrument tag represents a flow indicating controller. "PT" represents a pressure transmitter. You can find identification letter symbology information on the ISA Web site at http://www.isa.org.

Tag Numbers

Numbers on P&ID symbols represent instrument tag numbers. Often these numbers are associated with a particular control loop (e.g., flow transmitter 123). See Figure 7.13.



Identification Letters and Tag Number

Activities

19. The initial letter on an ISA symbol indicates the measured variable. Is this statement true or false?

20. What does the third letter on an ISA symbol indicate?

    1 Device function or a modifier
    2 Measured variable
    3 Readout
    4 Type of process fluid

ISA Symbology

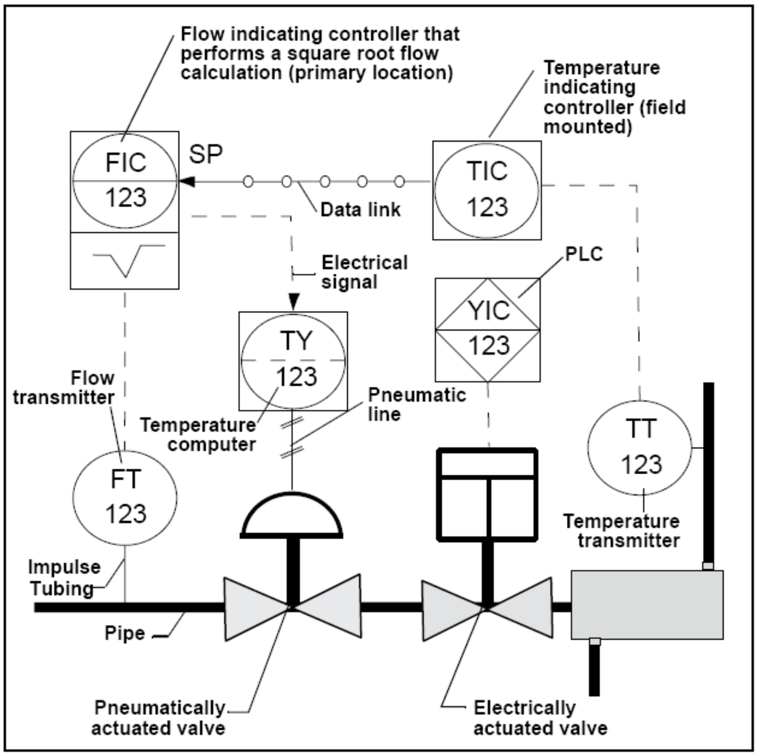
	Measured Variable	Modifier	Readout	Device Function	Modifier
A	Analysis		Alarm		
B	Burner, combustion		User's choice	User's choice	User's choice
C	User's choice			Control	
D	User's choice	Differential			
E	Voltage		Sensor (primary element)		
F	Flow rate	Ration (fraction)			
G	User's choice		Glass, viewing device		
H	Hand				High
I	Electrical Current		Indication		
J	Power	Scan			
K	Time, time schedule	Time rate of change		Control station	
L	Level		Light		Low
M	User's choice	Momentary			Middle, intermediate
N	User's choice		User's choice	User's choice	User's choice
O	User's choice		Orifice, restriction		
P	Pressure, vacuum		Point, test connection		
Q	Quantity	Integrate, totalizer			
R	Radiation		Record		
S	Speed, frequency	Safety		Switch	
T	Temperature			Transmit	
U	Multivariable		Multifunction	Multifunction	Multifunction
V	Vibration, mechanical analysis			Valve, damper, louver	
W	Weight, force		Well		
X	Unclassified	X axis	Unclassified	Unclassified	Unclassified
Y	Event, state, or presence	Y axis		Relay, compute, convert	
Z	Position, dimension	Z axis		Driver, actuator	

ISA Identification Letters

ISA Symbology

ISA Symbology Review

Figure 7.14 shows the elements of ISA symbology used in a P&ID.



P&ID with ISA Symbology

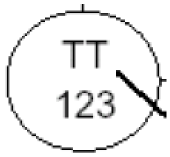
Activities

21. In Figure 7.14, what kind of signal is transmitted out from the temperature transmitter?

1 Data link
2 Mechanical signal
3 Electrical signal
4 Pneumatic signal

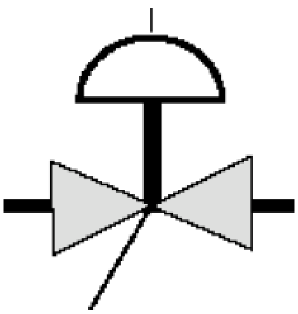
Match the ISA symbols in Column A with its respective description in Column B.

(1)



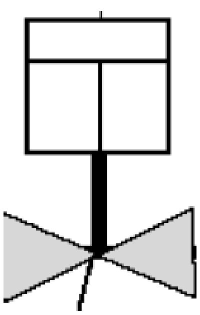
(A) Programmable logic control

(2)



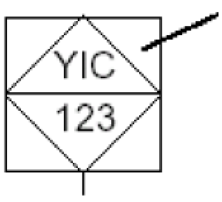
(B) Temperature transmitter

(3)



(C) Pneumatically actuated valve

(4)



(D) Electrically actuated valve