

P&IDs and Symbols

A Primer for Students who have not taken EMEC125

EMEC130



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P&ID – Widely Understood?



- P&ID is an acronym that is well understood to be the document used to define a process.
- Definition:
 - “A schematic diagram of the relationship between instruments, controllers, piping, and system equipment.” (Kirk, Weedon, & Kirk, 2014, p. 23)
- P&IDs are a symbol based schematic language that once understood, adds simplicity to the information being presented.
- They can also be confusing when a unique symbol appears.
- There is no real standard for what should be included on the drawing.

P&ID Acronym



- What does P&ID stand for?
- The letter meanings are not universal.
- ‘P’ could stand for “Piping” or it could stand for “Process”.
- ‘I’ could represent “Instrumentation” or represent “Instrument”.
- ‘D’ could mean “Drawing” or it could mean “Diagram”.
- Which ever is used, including those not listed, we are all talking about the same document(s).

New ISA Standard – ISA-5.7 *(Not Yet Released)*

- As mentioned, “there is no universal, national, international or international multi-discipline standard that covers the development and content of P&IDs” (Meier & Meier, 2011, p. 27)
- The ISA is in the process of creating a standard that will be known as: ISA-5.7 and is based on the Process Industries Practice (PIP) PIC 001.
- There is a standard that governs the symbols used on P&IDs. This standard is ANSI/ISA-5.1-2009 Instrument Symbols and Identifications. (See the introduction to this course)

What Comes From P&IDs?

- Instrument Lists or Index
 - Documents specifications, acquisition and installation
- Motor Lists
 - Size, horsepower, voltage
- Piping
 - Line lists, sizes, service and purpose
- Tanks & Vessels
 - Information about tanks and vessels
- All this information is used to lay out equipment, start specifying and purchasing the necessary equipment.

Control Loop

- A collection of equipment consisting of at least three devices used to automatically control a process or a part of a process
- The three most common devices is:
 - A transmitter used to sense the PV and transmit the measured value to a controller
 - A controller used to compare the PV with a setpoint and generate a signal based on that comparison
 - A final control element that corrects the process

ANSI/ISA-5.1

- As stated earlier, the ANSI/ISA-5.1 is most often used by designers as the standard for symbology. Following is a direct quote from the standard:

“The symbols and identification methods contained in this standard have evolved by the consensus method and are intended for wide application throughout all industries. The symbols and designations are used as conceptualizing aids, as design tools, as teaching devices, and as a concise and specific means of communication in all types and kinds of technical, engineering, procurement, construction, and maintenance documents and not just in Piping and Instrumentation Diagrams.” (International Society of Automation, 2009)

Identification Letters

- The ANSI/ISA-5.1-2009 Instrumentation Symbols and Identification standard lists the preferred First Letter and Succeeding Letters.
- The standard also lists typical letter combinations.
- Keep these lists handy when reading or creating P&ID's.

ISA Identification Letters

Table 4.1 — Identification letters

Note: Numbers in parentheses refer to the preceding explanatory notes in Clause 4.2.

	First letters (1)		Succeeding letters (15)		
	Column 1	Column 2	Column 3	Column 4	Column 5
	Measured/Initiating Variable	Variable Modifier (10)	Readout/Passive Function	Output/Active Function	Function Modifier
A	Analysis (2)(3)(4)		Alarm		
B	Burner, Combustion (2)		User's Choice (5)	User's Choice (5)	User's Choice (5)
C	User's Choice (3a)(5)			Control (23a)(23e)	Close (27b)
D	User's Choice (3a)(5)	Difference, Differential, (11a)(12a)			Deviation (28)
E	Voltage (2)		Sensor, Primary Element		
F	Flow, Flow Rate (2)	Ratio (12b)			
G	User's Choice		Glass, Gauge, Viewing Device (16)		
H	Hand (2)				High (27a)(28a)(29)
I	Current (2)		Indicate (17)		

Instrument Identification (Tag Numbers)

- All instruments should have a metal, plastic or paper tag attached to them that states an instrument identification number; known as a “Tag Number”.
- There are several numbering schemes; however, the ISA standard, ISA-RP-5.1 (1949) superseded by ANSI/ISA-5.1-1984 (R 1992) superseded by ANSI/ISA-5.1-2009 is the most common.
- Tag numbers are an alpha-numeric code where the:
 - Alpha portion should be no more than four upper case characters
 - Numeric portion should be know more than four digits.
- The smaller the tag number, the better.

Typical Instrument Tag Number

- PDT 102 – Instrument Identification or Tag Number
 - PDT – Function Identification
 - P 102 – Loop Identification
 - 102 – Loop Number
 - P - First Letter
 - DT - Succeeding Letters
- The most common identifiers are used for the most common process variables in process control:
 - F – Flow
 - L – Level
 - P – Pressure
 - T - Temperature

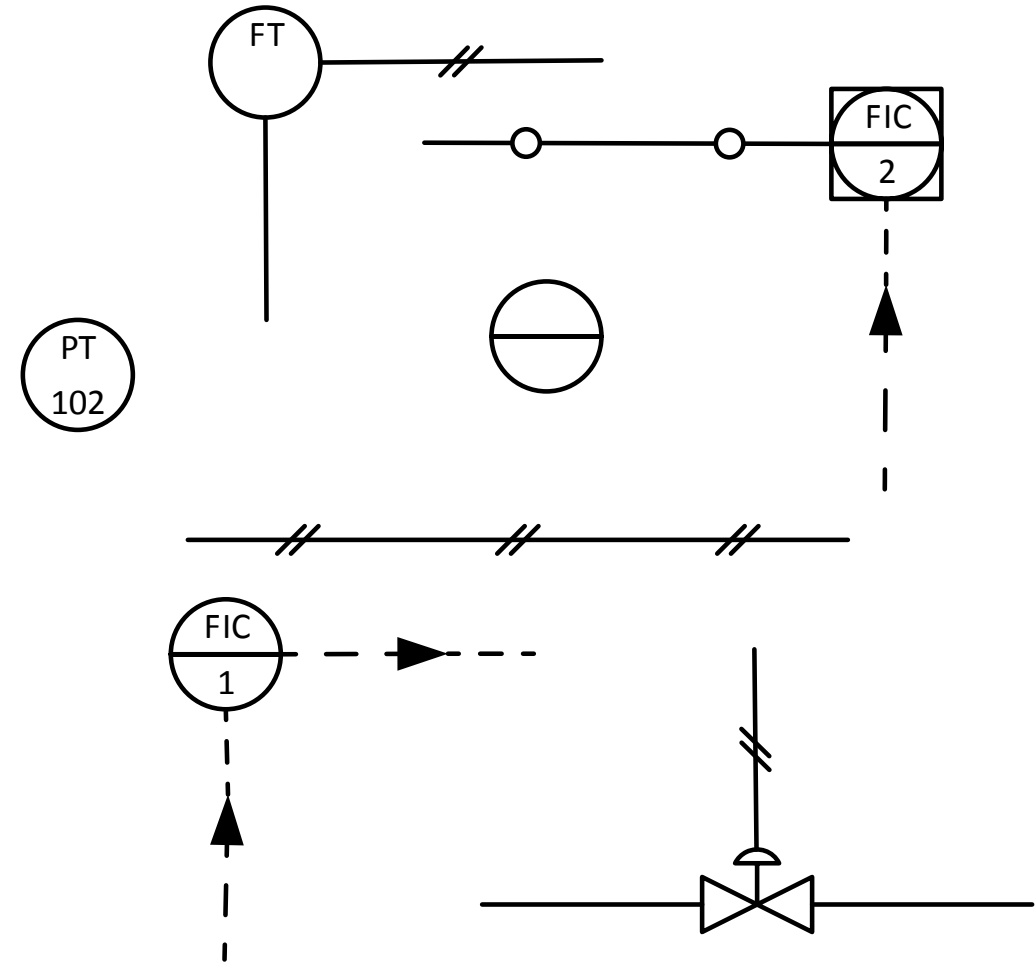
Note: Hyphens are optional as separators

The Letter 'X' as a First Letter

- The letter 'X' as a first letter in a special case.
- The ANSI/ISA-5.1-2009 Standard states:
 - “First-Letter or Succeeding-Letter for unclassified devices or functions (X), for non-repetitive meanings that shall be defined outside tagging bubbles or by a note in the document.” (International Society of Automation, 2009)
- A legend sheet and descriptive letters next to the bubble should define the function letter 'X'.
- Proper use is to not use the letter 'X' frequently and when used should only be used once, or at least in a limited capacity

Symbology – Building Blocks

- Circles (Bubbles)
- Squares & Rectangles
- Triangles
- Half Circles
- Lines

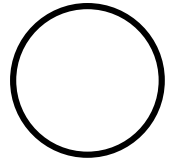


Instrument Location Information

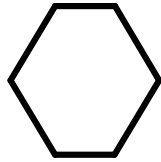
- ISA standard instrument symbols, location and accessibility
- Symbols are used to help identify the type of:
 - Instrument
 - Location
 - Located in the field
 - Not panel, console or cabinet mounted
 - Visible at the field location
 - Accessible to the operator
 - Located in or on front of central or main console or panel
 - Visible on front panel
 - Location at rear of main or central panel
 - Not accessible to the operator

Instrumentation Devices or Function Symbols

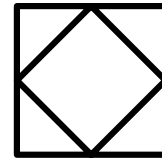
Field Mounted



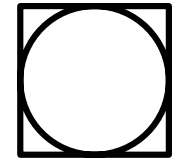
Discrete
Instruments



Computer
Systems
And
Software



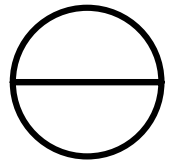
Alternate
Choice
Or
Safety
Instrumented
System



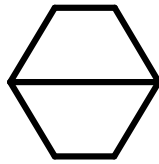
Primary
Choice
Or
Basic
Process
Control
System

Instrumentation Devices or Function Symbols

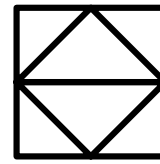
Normally Accessible to Operator



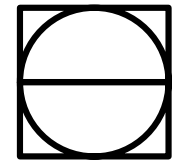
Discrete
Instruments



Computer
Systems
And
Software



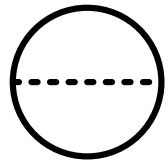
Alternate
Choice
Or
Safety
Instrumented
System



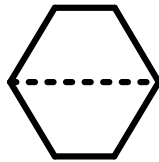
Primary
Choice
Or
Basic
Process
Control
System

Instrumentation Devices and Function Symbols

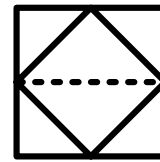
Normally inaccessible to the operator or behind-the-panel devices or functions



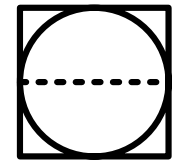
Discrete
Instruments



Computer
Systems
And
Software



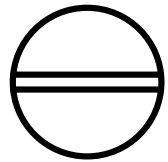
Alternate
Choice
Or
Safety
Instrumented
System



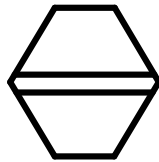
Primary
Choice
Or
Basic
Process
Control
System

Instrumentation Devices and Function Symbols

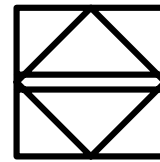
Auxiliary location normally accessible to the operator



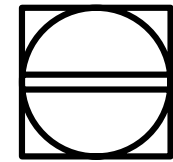
Discrete
Instruments



Computer
Systems
And
Software



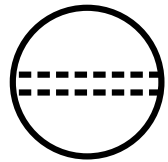
Alternate
Choice
Or
Safety
Instrumented
System



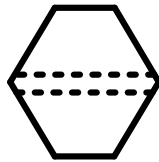
Primary
Choice
Or
Basic
Process
Control
System

Instrumentation Devices and Function Symbols

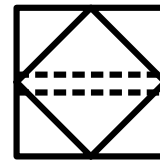
Normally inaccessible to the operator or behind-the-panel devices or functions



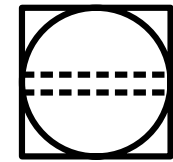
Discrete
Instruments



Computer
Systems
And
Software



Alternate
Choice
Or
Safety
Instrumented
System

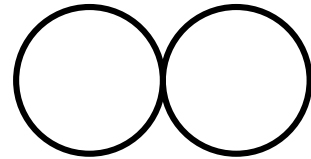


Primary
Choice
Or
Basic
Process
Control
System

Instrumentation Devices and Function Symbols



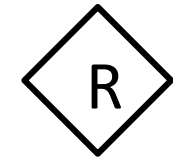
Instrument
With
Long Tag
Number



Instruments
Sharing
Common
Housing *



Purge or
Flush
Device **

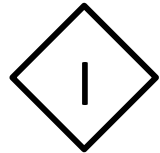


Rest for
Latch-Type
Actuator **

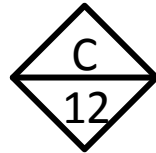
* It is not mandatory to show a common housing

** These diamonds are approximately half the size of the larger ones

Instrumentation Devices and Function Symbols



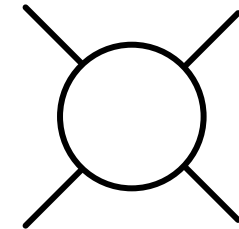
Undefined
Interlock
Logic ***



Panel
Mounted
Patchboard
Point 12



Diaphragm
Seal



Pilot
Light

*** For specific logic symbols, see ANSI/ISA Standard S5.2

Instrument Line Symbols

Instrument Supply
Or Connection to Process



Undefined Signal



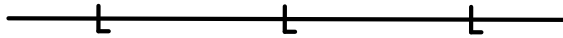
Pneumatic Signal



Electrical Signal

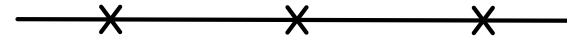


Hydraulic Signal



Instrument Line Symbols

Capillary Tube



Electromagnetic or Sonic
Signal (Guided) ***



Electromagnetic or Sonic
Signal (Not Guided) ***



Internal System Link
(Software or Data Link)



*** Electromagnetic phenomena include heat, radio waves, nuclear radiation, and light.

Instrument Line Symbols

Mechanical Link



Optional Binary (ON – OFF) Symbols

Pneumatic Binary Signal



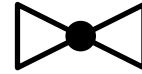
Electric Binary Signal



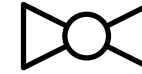
Final Control Elements - Valves



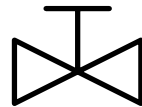
- Generic Two-way
- Straight globe
- Gate



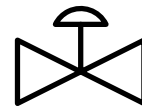
- Generic Two-way
- Straight globe
- Gate



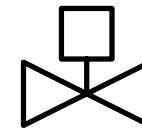
Ball Valve



Screw-down



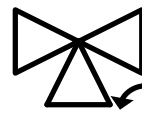
Generic 2-Way



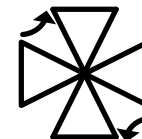
Powered



Generic Two-Way
Angle

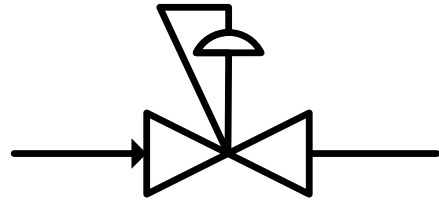


Generic 3-Way

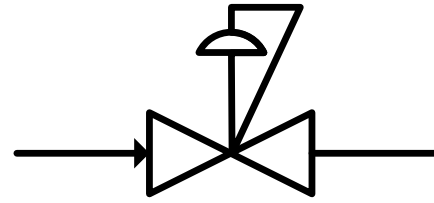


Generic 4-Way

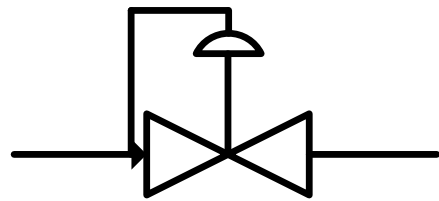
Final Control Elements - Valves



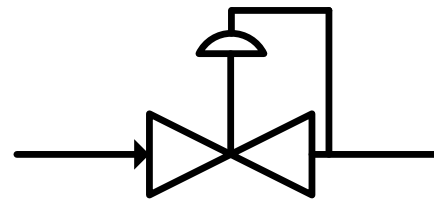
Backpressure regulator, Internal pressure tap



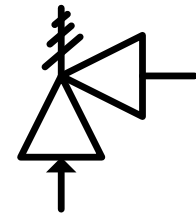
Pressure-reducing regulator, Internal pressure tap



Backpressure regulator, External pressure tap

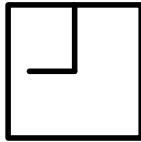


Pressure-reducing regulator, External pressure tap

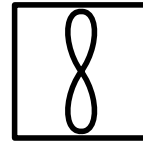


Generic pressure safety valve, Pressure relief valve

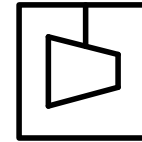
Primary Flow Measurement - Flowmeters



Standard Pitot Tube



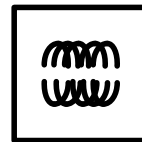
Turbine, Propeller



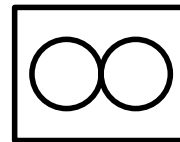
Vortex Shedding



Magnetic 01



Magnetic 02

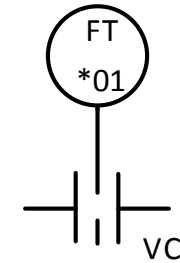
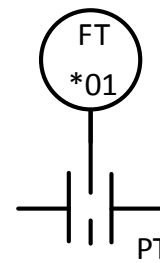
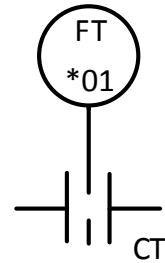
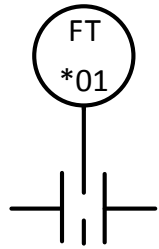


Positive Displacement



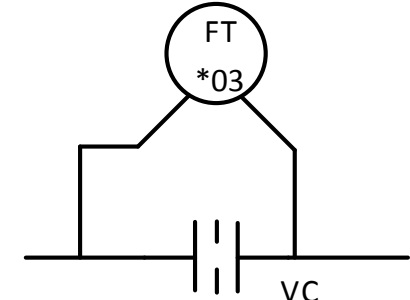
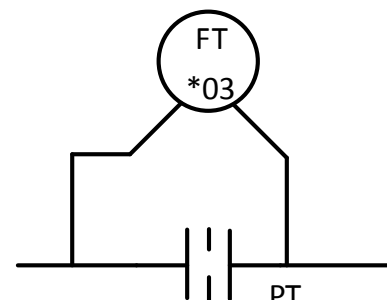
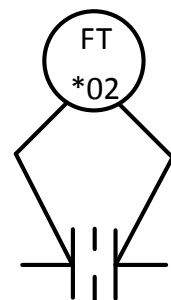
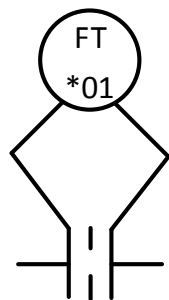
Variable Area

Differential Pressure - Flowmeters

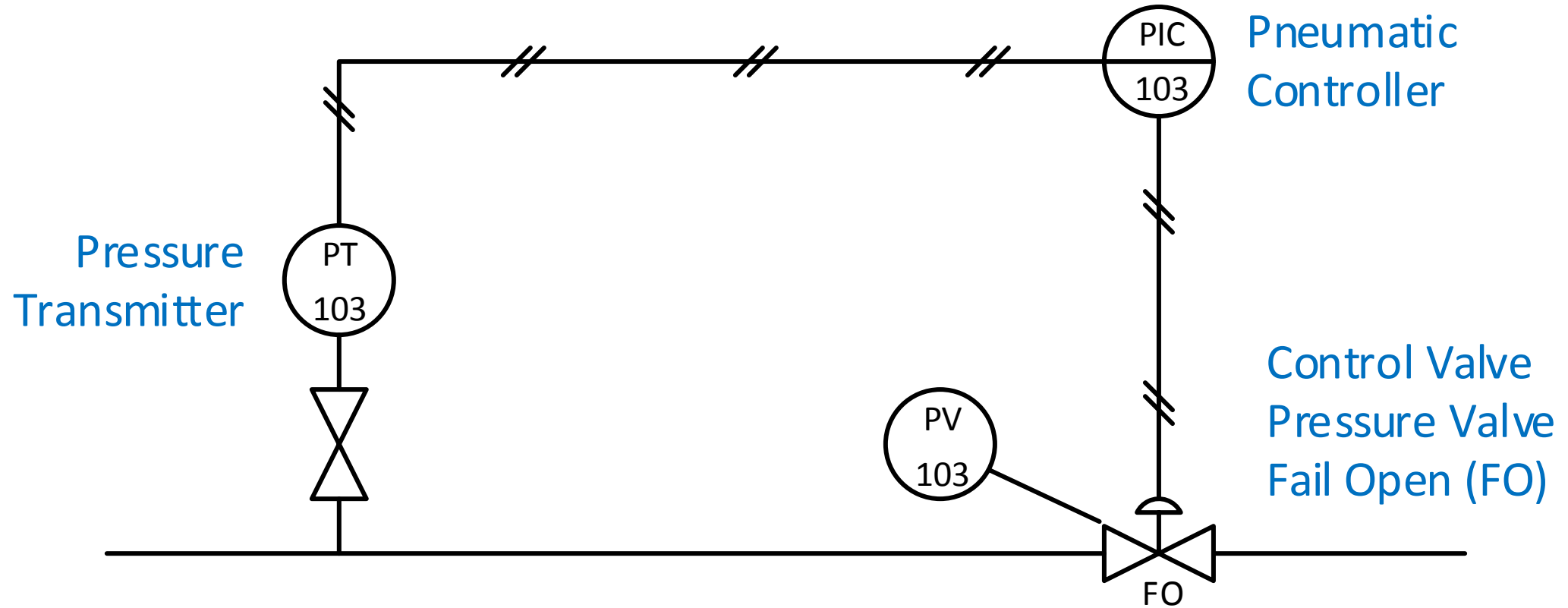


Single connection. The CT = Corner Tap, PT = Pipe Tap, VC = Vena Contracta Taps. These three are not very common.

Double connections to the process. PT = Pipe Tap, VC = Vena Contracta Taps.



Pneumatic Control Loop



Control Loop 103 – Pressure Control Loop

Valve Failures

- Valves can fail in various positions
 - Fail Open (FO)
 - Fail Closed (FC)
 - Fail Locked (FL)
 - Fail in Last Position, Drift Open (FL/DO)
 - Fail in Last Position, Drift Closed (FL/DC)
- Valves are shown on a P&ID by a shape that resembles a bow tie
- Actuators are shown with a line from the bow tie junction to a shape such as a half circle, a square, a horizontal line, etc. (More on valve symbols later in the chapter.)
- The next slide shows symbols for valve failures

Valve Failures - Symbols

Method A

Method B



Fail to open position



Fail to closed position



Failed to last position



Fail to last position, Drift open



Fail to last position, Drift closed

NOTE:

1. Users engineering a design standards, practices, and/or guidelines shall document which symbols have been selected.
2. The symbols are applicable to all types of control valves and actuators.

Electronic Control Loop

