P&IDs, Piping and Instrument Diagrams

An Overview of the Diagram, Its Purpose and Use

Materials: Michael Sharpe

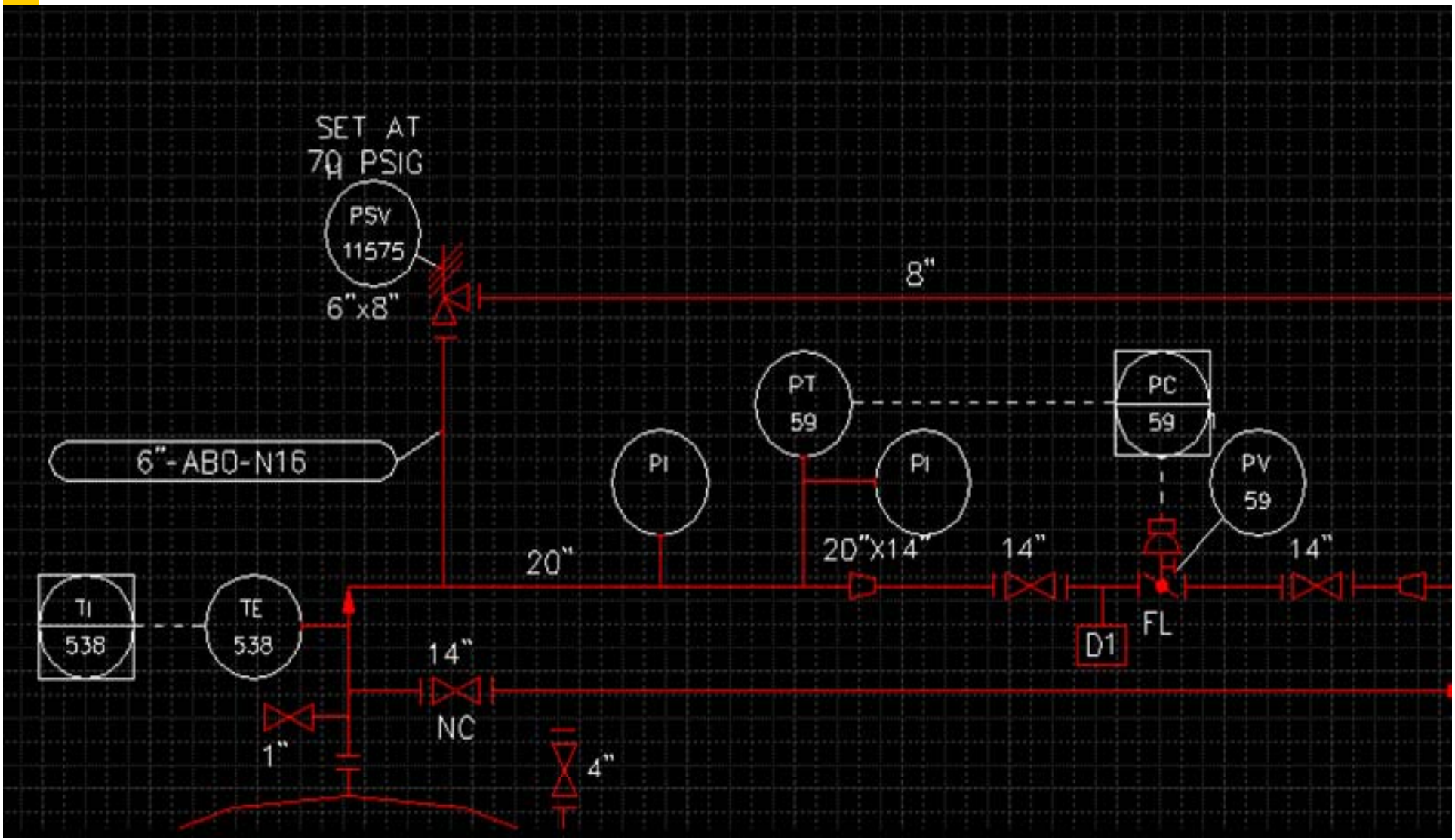
Objectives

- To understand what a P&ID is
- The information and details it provides
- The industry standard symbols which are used (ISA)
- How the P&ID is utilized by:
  - The client, plant personnel
  - Honeywell IAC
- How the P&ID works with loop diagrams

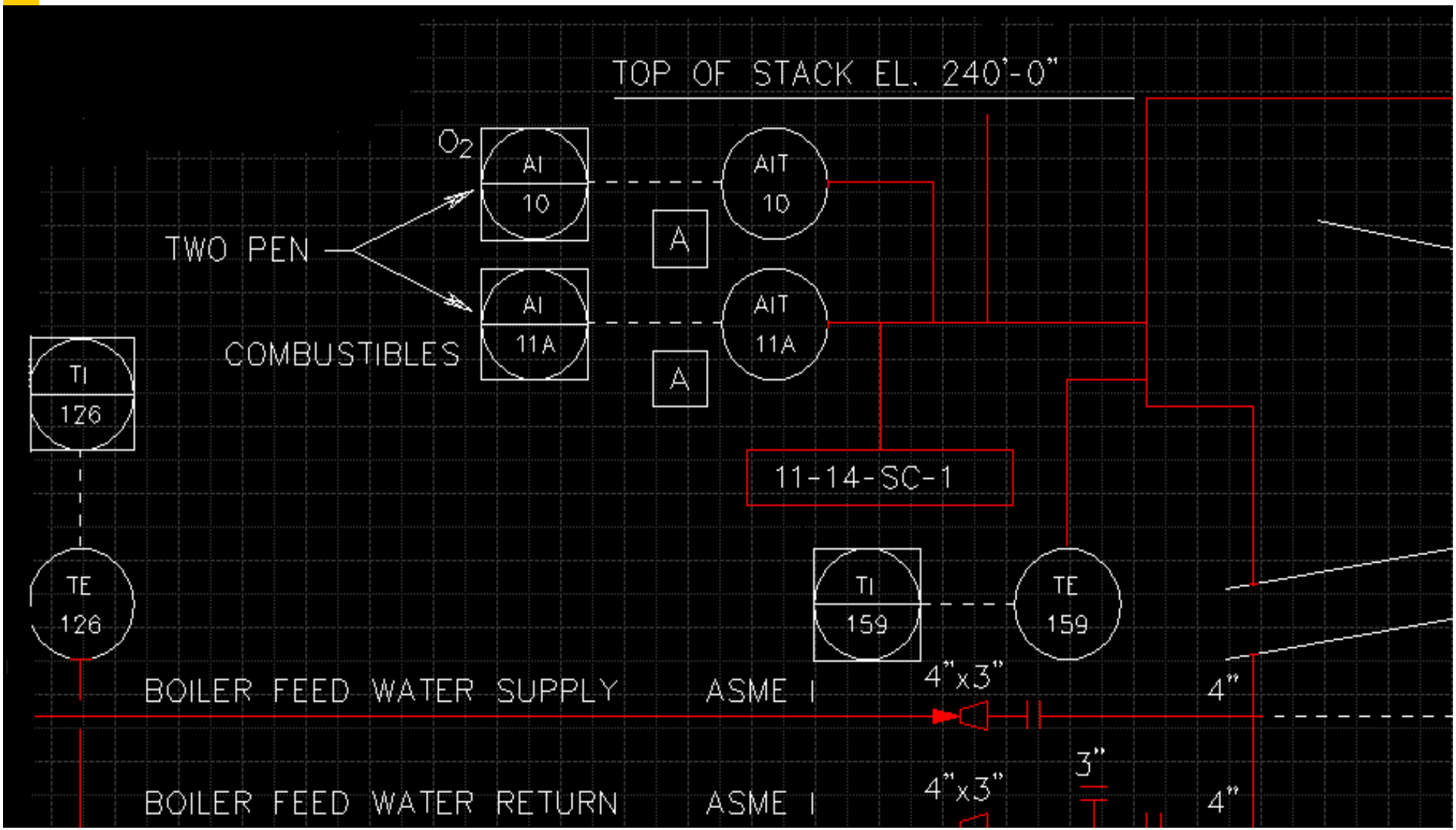
1. What is a P&ID?

A. (Piping and Instrument Diagram) Generally depicts (1) process system within a plant. (Each process has its own P&ID)
B. A detailed compilation of a process system.
C. Generally provides a mechanical overview of the process system.(Some electrical detail is shown)
D. The “Title Block” generally provides the name or description of the process system.
E. The base document for controlling and documenting changes to the process system. Precedes revisions to the loop diagrams, isometrics, control schematics, etc.

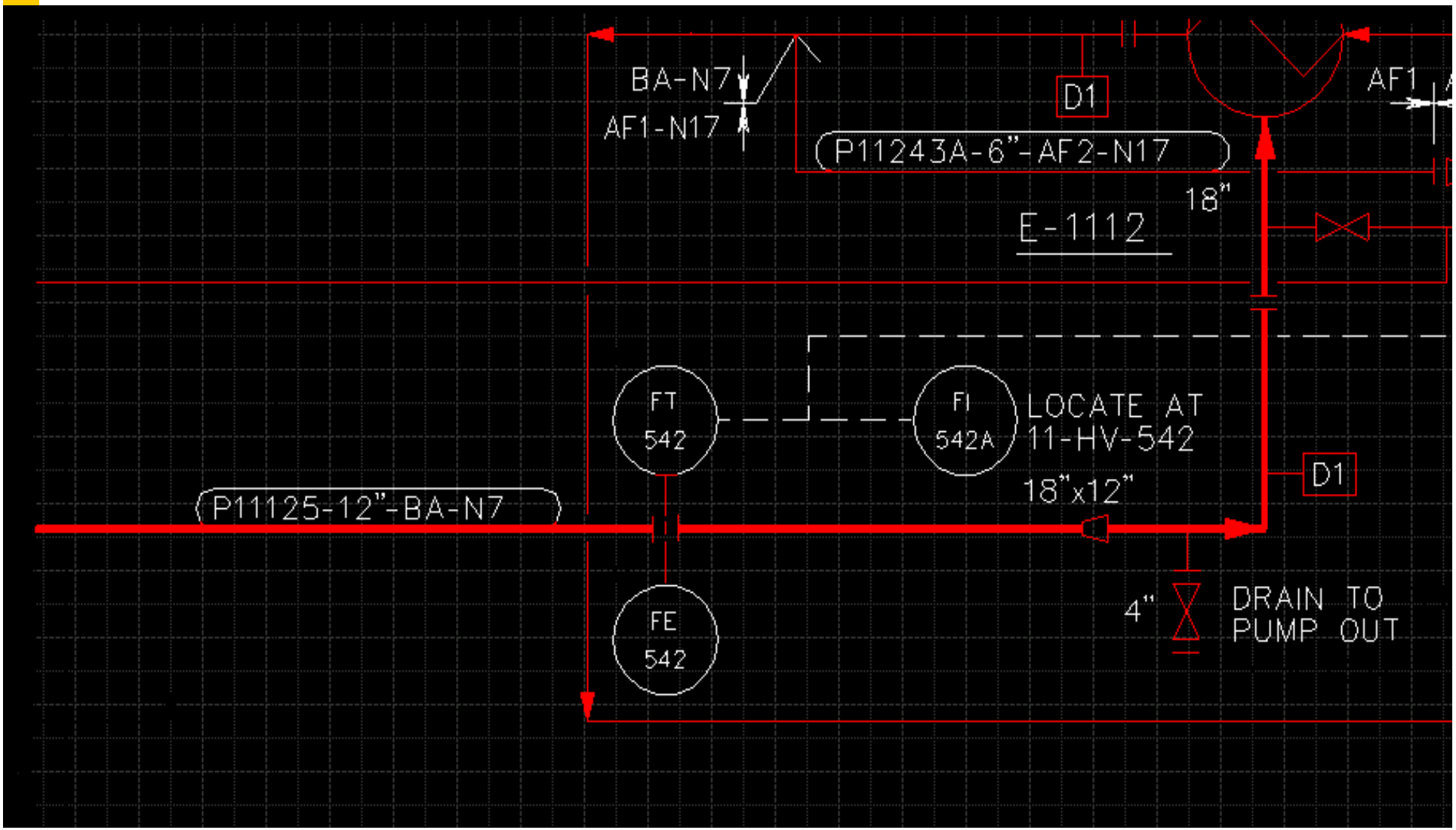
A Basic View of a P&ID, Example 1



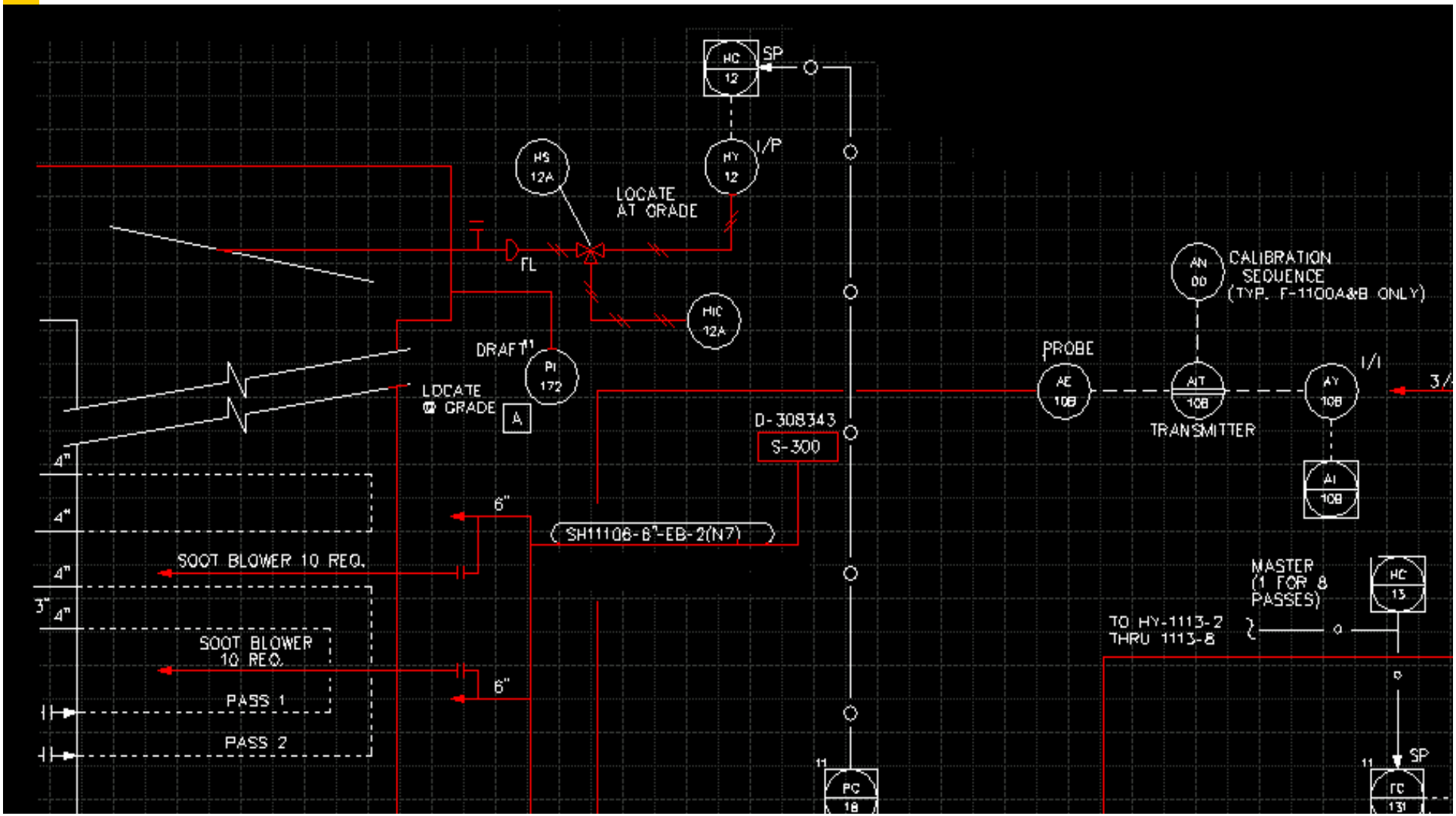
A Basic View of a P&ID, Example 2



A Basic View of a P&ID, Example 3



A Basic View of a P&ID, Example 4



2. What detail does the P&ID provide?

A. Depicts a “One Line” schematic view of the mechanical components of a system or “Process”.

- Although some electrical detail is shown, the P&ID is intended primarily to show mechanical equipment, “Instrumentation”, piping and “Controls” devices.

2. What detail does the P&ID provide?

B. Defines piping sizes and material specifications.

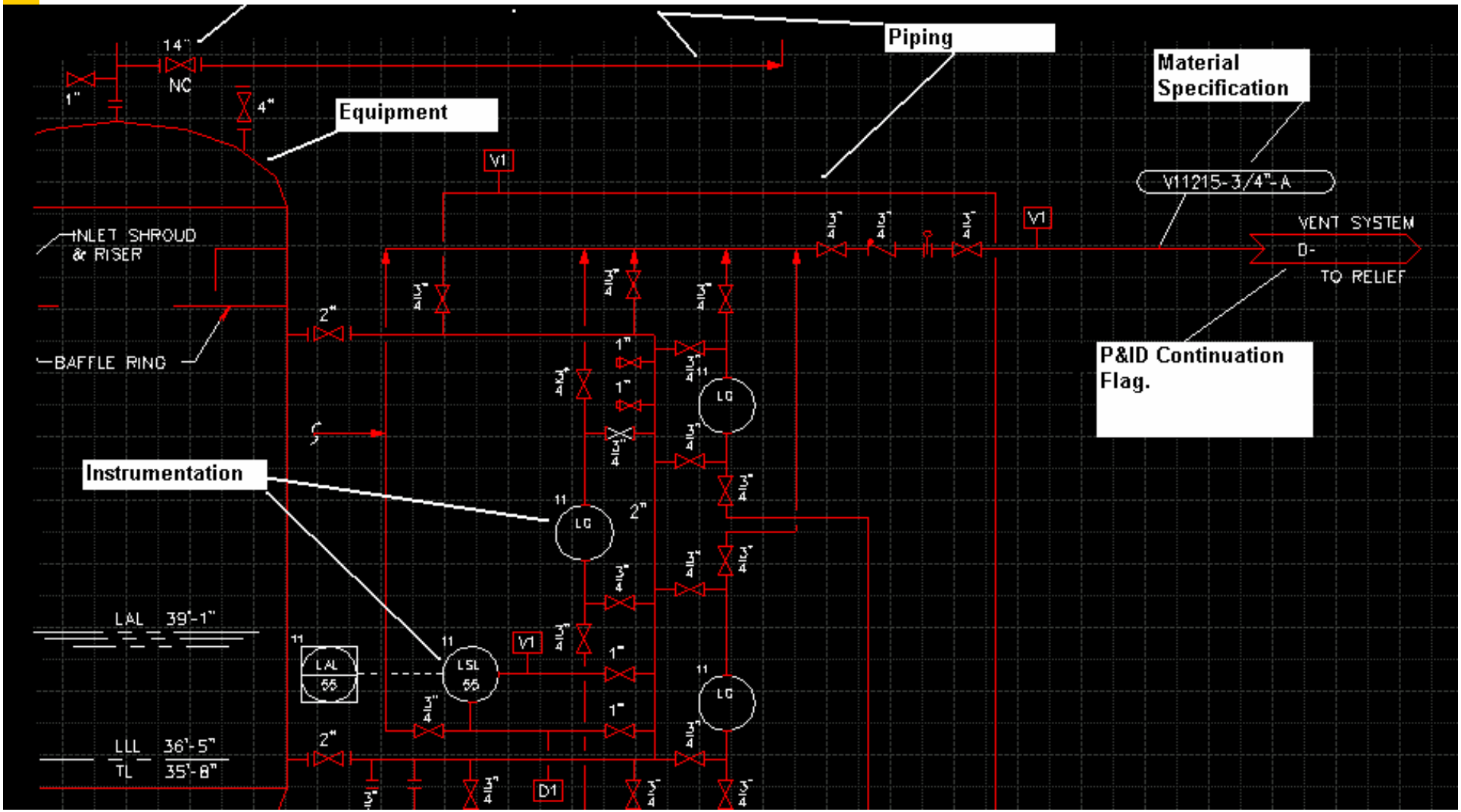
C. Provides connecting P&ID numbers.

D. Shows system “FLOW”.

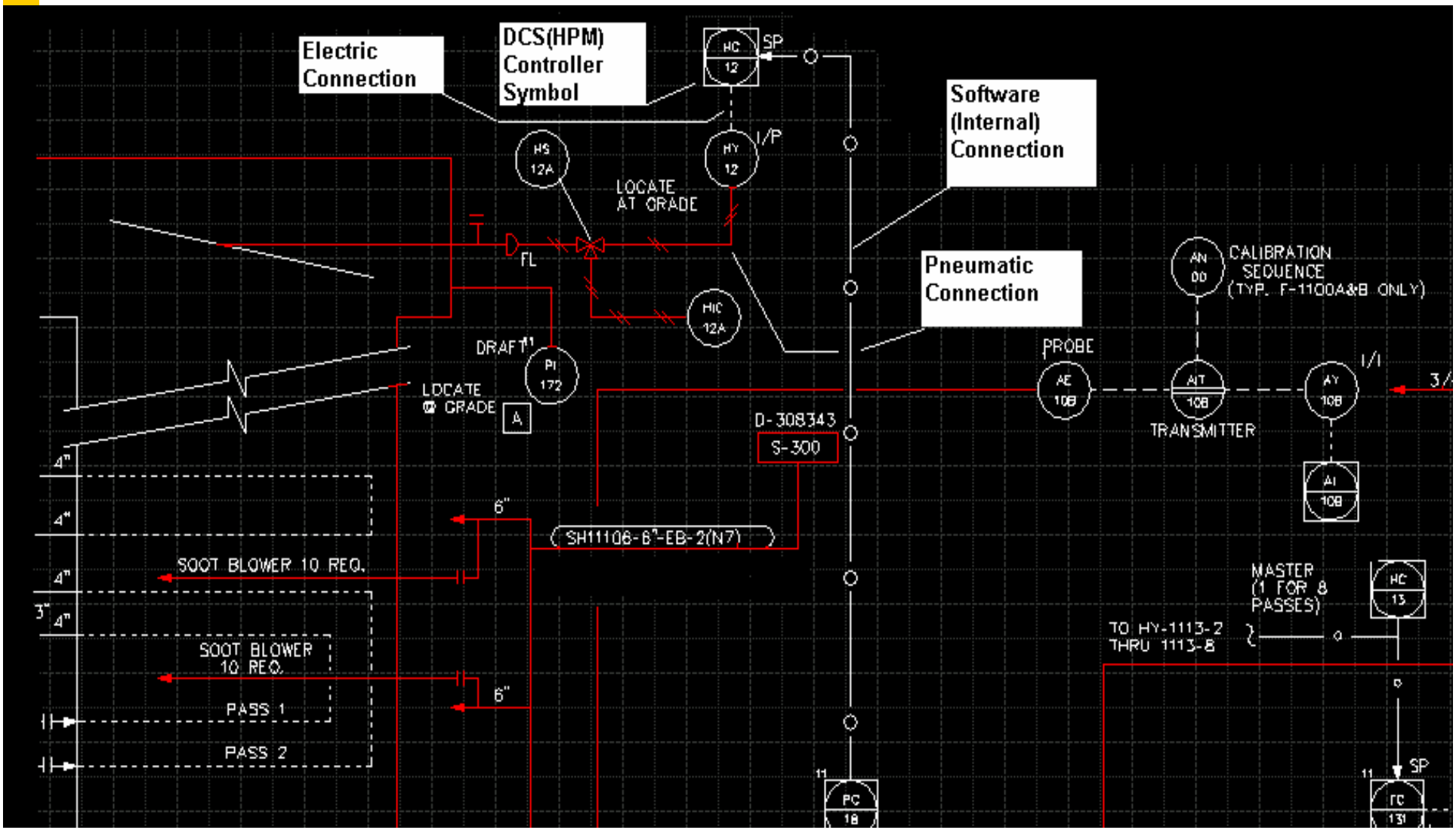
E. Shows alarms types at the DCS controllers.

F. Shows electrical, pneumatic and software connections or ties between the “DCS or PLC Controllers” and the various field instruments and final control elements.

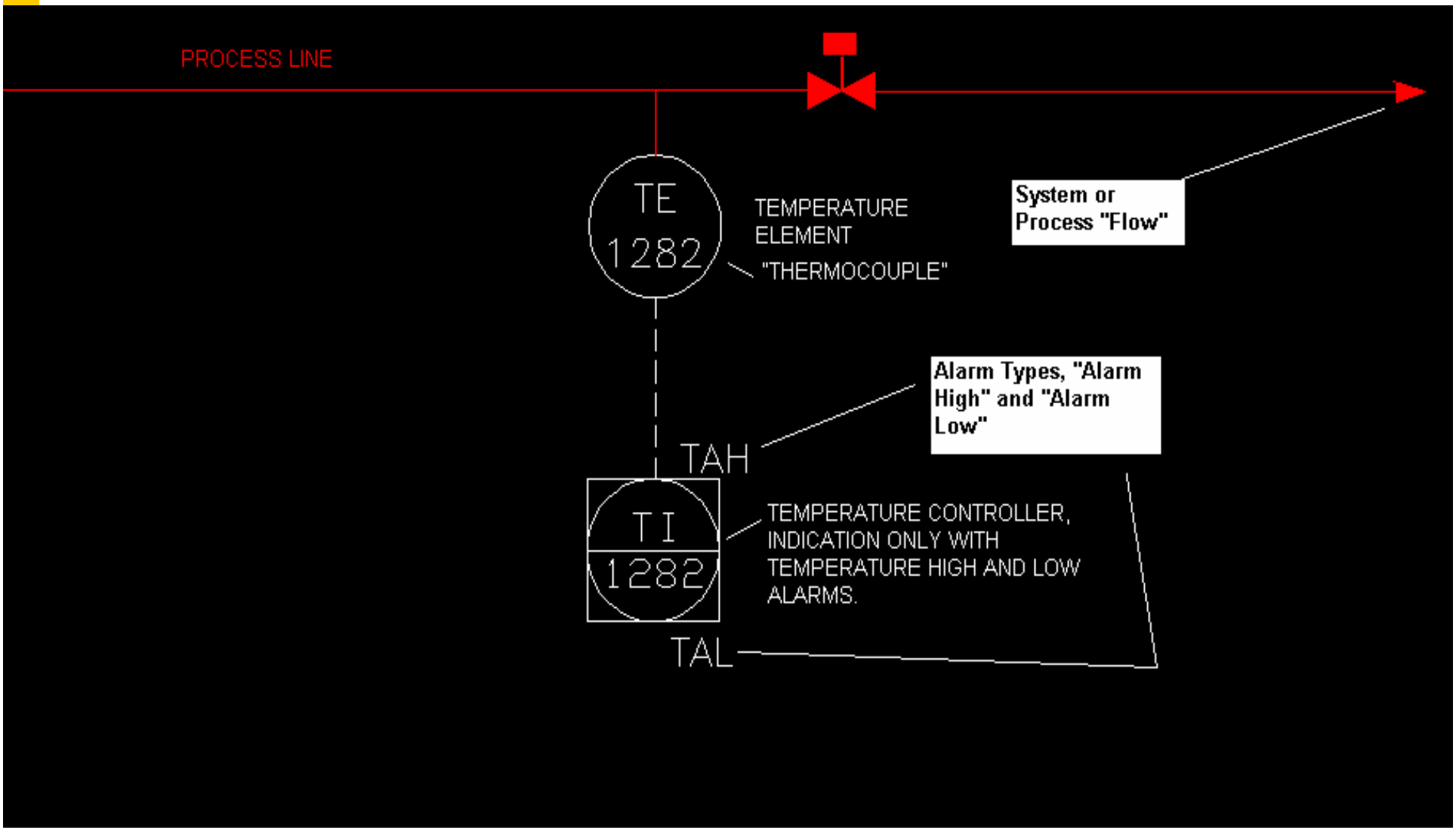
P&ID Detail, Example 1



P&ID Detail, Example 2



P&ID Detail, Example 3



3. What are the Industry Standard Symbols?

Industry standard symbols used are ISA (Instrument Society of America), also known as The International Society for Measurement and Control.

NOTE: Many clients will develop their own symbols library used in conjunction with ISA. When working with "Others" documents, be aware of their symbols as well!

A. DCS / PLC (Controllers)

B. Local Field Devices

C. Panel Mounted Devices

D. Connection Types

E. Valves Types

3. What are the Industry Standard Symbols?

F. Interlocks

G. Equipment

H. Device Tagging Convention

ISA General Notes

ISA was developed as a way of bringing consistency and uniformity to the instrument and controls world **in terms of the definitions and symbols used. ISA allows for a means of communicating and conveying information in a fashion that anyone with a limited instrument background could understand. The student here should be aware that *ISA is a "Consensus" document rather than a mandatory one.* This means anyone in the instrument/controls business will generally make an effort to abide by ISA Standards, but they are not bound by "THE" standard. Consequently, the *symbols will vary somewhat client to client*.**

ISA has numerous user notes of which you should be aware. The following slides provide a somewhat condensed and in most cases paraphrased version of some of what the author here believes to be the most important notes. The student should make himself aware of all the user notes by reviewing a complete copy of the ANSI/ISA Standard at their convenience.

ISA General Notes, Specific

ISA General Notes
Refer to ANSI/ISA-S5.1-1984 Sections 1 thru 6

1. The ISA Standard was established as a uniform means of designating instruments and instrumentation systems used for measurement and control.
   The ISA Standard is a consensus rather than a mandatory document!

2.1.2 "Process Equipment" symbols are not part of the ISA Standard.
The equipment symbols are developed and defined by the user! By equipment we mean pumps, vessels, heaters, fans, etc. Anything other than instruments or control devices.

2.3.1 The ISA Standard is suitable for use in: design sketches, technical papers, system, loop or logic diagrams, flow diagrams and P&ID's.

2.3.2 Intended to provide sufficient information to enable anyone with a reasonable level of controls or instrument knowledge to review and understand the measurement and control scheme as depicted in a given document.

2.6 Covers the identifications of an instrument and all other

ISA General Notes, Specific

ISA General Notes

Refer to ANSI/ISA-S5.1-1984 Sections 1 thru 6

4.2.1 The functional identification of instruments or control loop devices includes the first letter which identifies the measured or initiating variable and one or more succeeding letters identifying the function of that device.
Reference the "Identification Letter" tables included in this CBT for clarification.

4.4.2 The functional identification of an instrument is according to the function and not the construction.
An example would be a differential pressure recorder used for flow measurement would be given a tag "FR" for "Flow Recorder", not "DPR".

4.2.3 The first letter of functional identification is according to the measured or initiating variable, not the manipulating variable.
An example: a control valve used to control FLOW according to the dictates of a LEVEL controller would have a tag of "LCV" not "FCV". "LCV" matches the loop designator assigned to the controller and transmitter.

4.2.8 All letters of functional identification are uppercase (Capital).

4.3.1 Each instrument within a loop has assigned to it the same loop number.
What varies is the "Functional Identifiers".

ISA General Notes, Specific

ISA General Notes

Refer to ANSI/ISA-S5.1-1984 Sections 1 thru 6

4.3.3 If a given loop has more than one instrument with the same functional identification, a suffix may be added to those instruments to uniquely identify each.
An example would be where you have two transducers in a loop number 100, one transducer could be tagged FY100A and the second would be FY100B.
NOTE: When building a TDC database, care must be taken to ensure the above noted allowance does not conflict with the database logic!

4.4.4 A brief explanatory note may be added adjacent to a symbol on the diagram to clarify the function of the item.
You may add any clarifying notes you think necessary to your sketches and diagrams.

4.4.5 Signal lines on a diagram may be drawn entering or leaving a symbol at any angle. Directional arrows should be added to signal lines when necessary to clarify the direction of flow of information.

4.4.9 The sequence in which the instruments or functions of a loop are connected on a diagram should reflect the functional logic or information flow.
This is an extremely important point to remember. Be sure the devices shown in the loop are in logical format to reflect how the loop functions.

ISA General Notes, Specific

ISA General Notes

Refer to ANSI/ISA-S5.1-1984 Sections 1 thru 6

4.4.10 The degree of detail to be applied to each document or sketch is entirely at the discretion of the user of the standard.

In general, the end user is allowed a great deal of flexibility in the use of the ISA Standard. Consistency in the application of this standard is a key element.

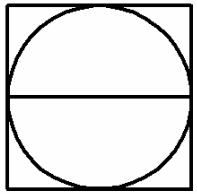
5.1(1) A users choice letter is intended to cover unlisted meanings that will be used repetitively in a particular project.

When reviewing the "Identification Letter" table in ISA, you will see there are many instances where the standard allows the user to designate the meaning of a particular letter. Think of these as "Wild Cards" and apply the meaning consistently in a given project.

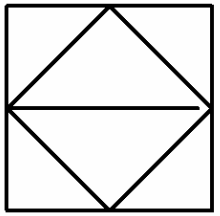
6.1 If a given drawing uses graphic symbols that are similar or identical in shape or configuration and that have different meanings because they are taken from different standards, adequate steps must be taken to avoid misinterpretation of the symbols used.

This is telling you the user to note in your "P&ID Symbols Standard" the precise meaning of the symbols used. The Symbols Standard is generally provided by the client to use in their drawings and documents. You are obligated to use your clients symbols unless specifically told not to.

DCS(HPM) and PLC Symbols

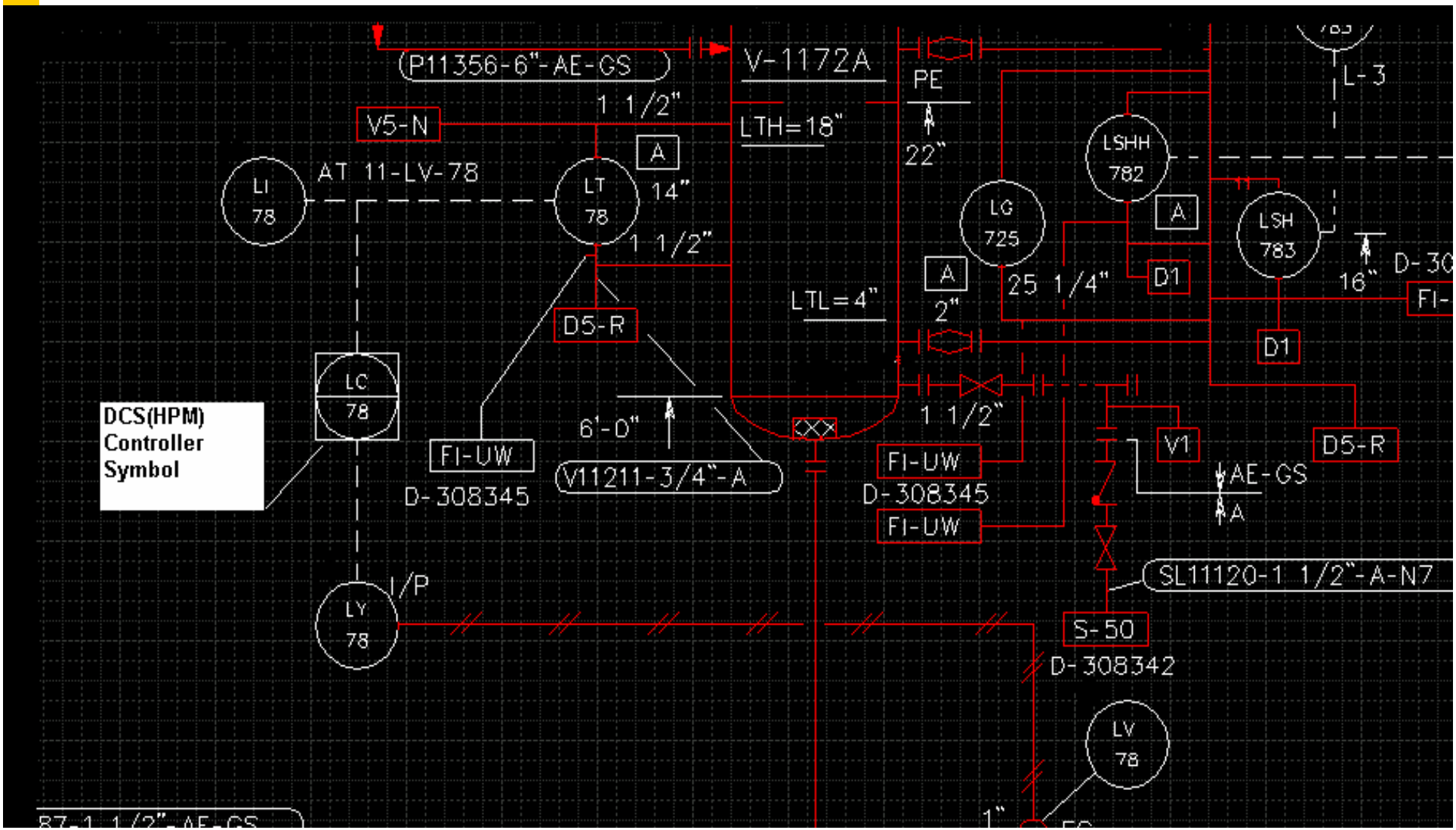


DCS or HPM Console Display.
(Operator Control, Software Point)

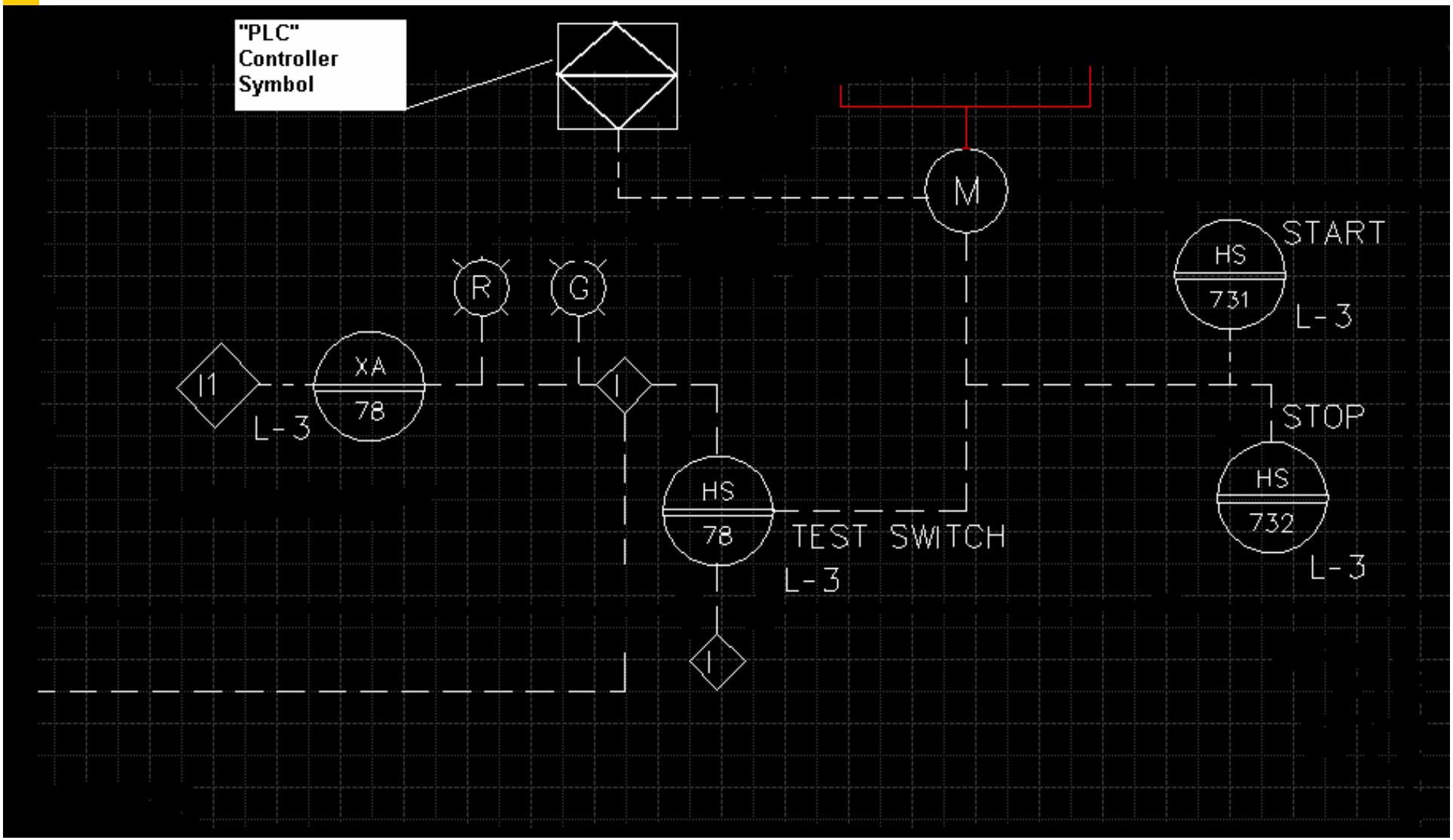


PLC Console Display.
(Operator Control, Software Point)

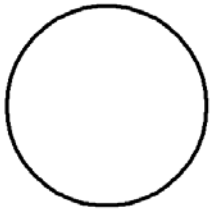
DCS(HPM) Symbol in P&ID View



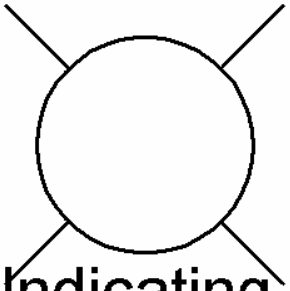
PLC Symbol in P&ID View



Local Field Device Symbols

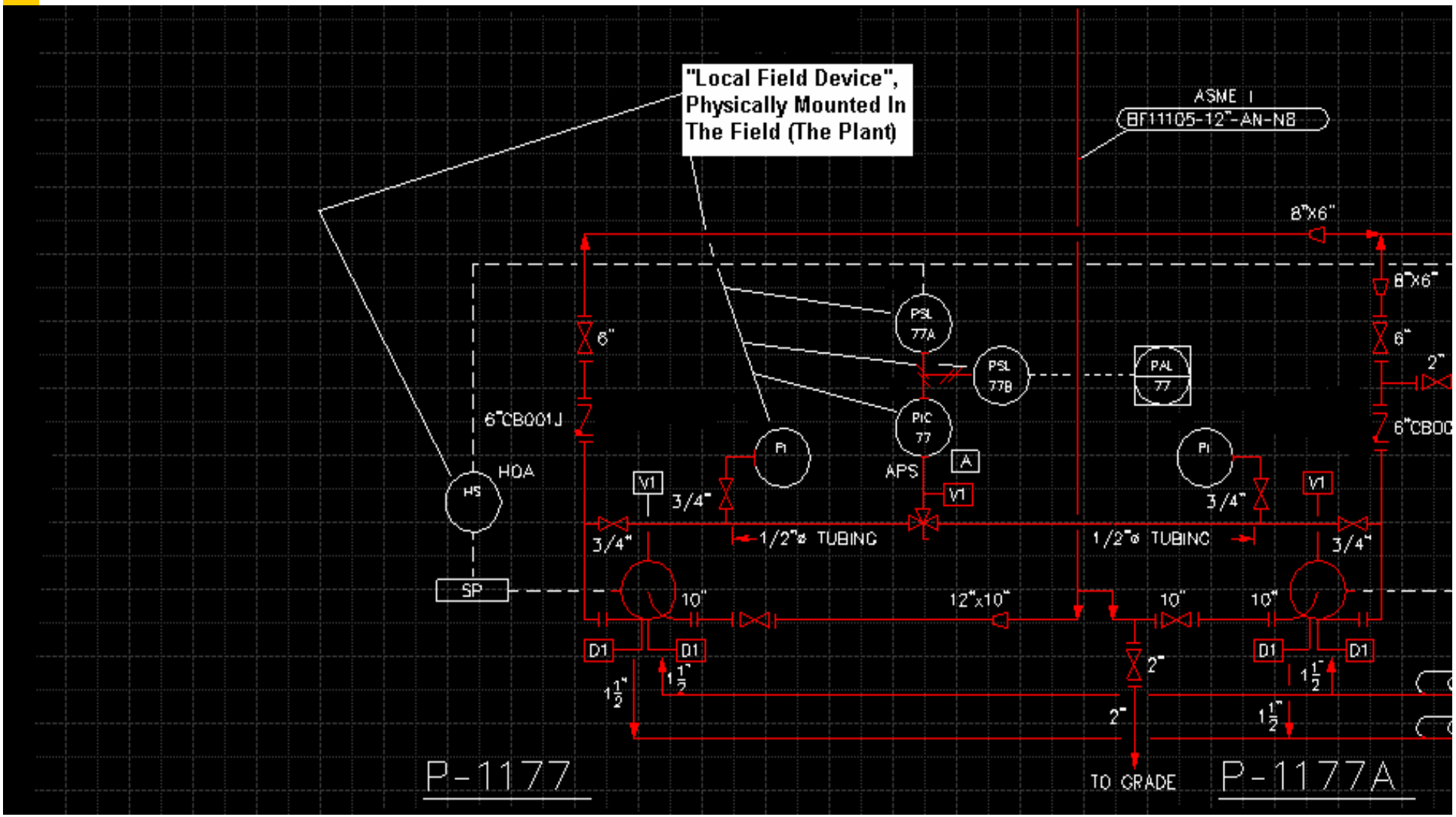


Instruments/Devices, Field Mounted. (Transmitters,Switches, Valves,Etc.)

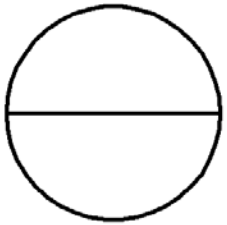


Local Indicating Light, Mounted In The Field At The Device. (Used To Show Device Energized, Device Position, Etc.)

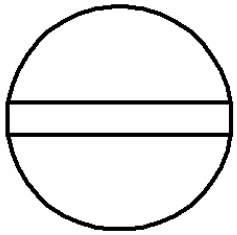
Local Field Devices in P&ID View



Panel Mounted Device Symbols

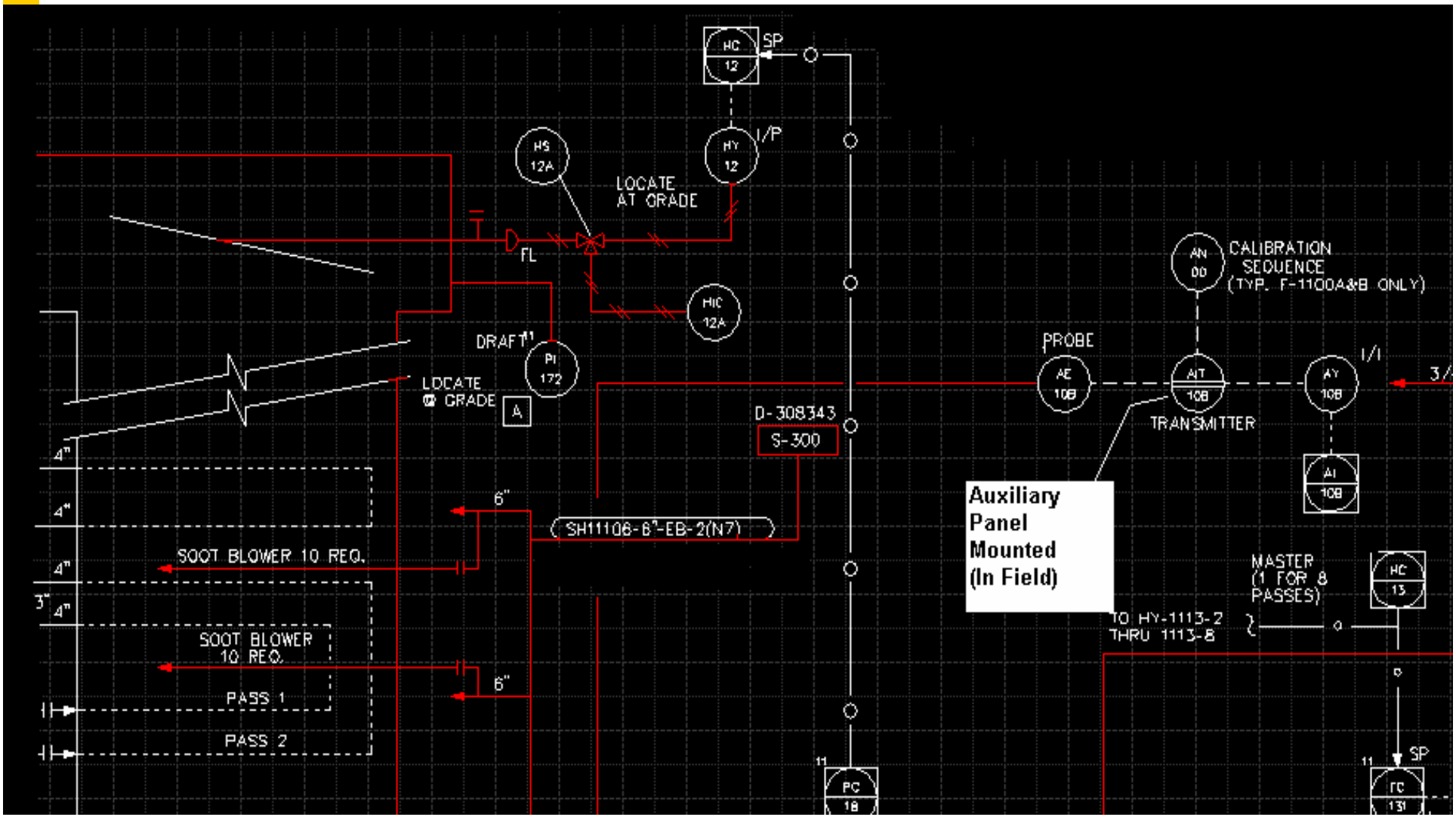


Instruments/Devices, Primary Panel Mounted. (Mounted In A Control Room Panel)



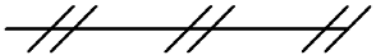
Instruments/Devices, Auxiliary Panel Mounted. (Mounted In A Field Panel)

Panel Mounted Device in P&ID View

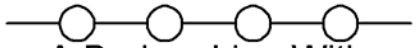


Connection Types, Sheet 1

Broken Line.
Denotes An Electric Signal Line.
(Generally From Field Devices To The DCS)



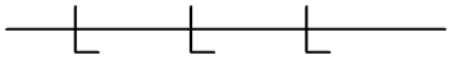
Solid Line With Cross Hatch.
Denotes A Pneumatic Signal Line.
(Generally From/To A Transducer)



A Broken Line With Open Circles.
Denotes Internal System Or Software Link.
(Such As The Links Between Controllers With-in The HPM)

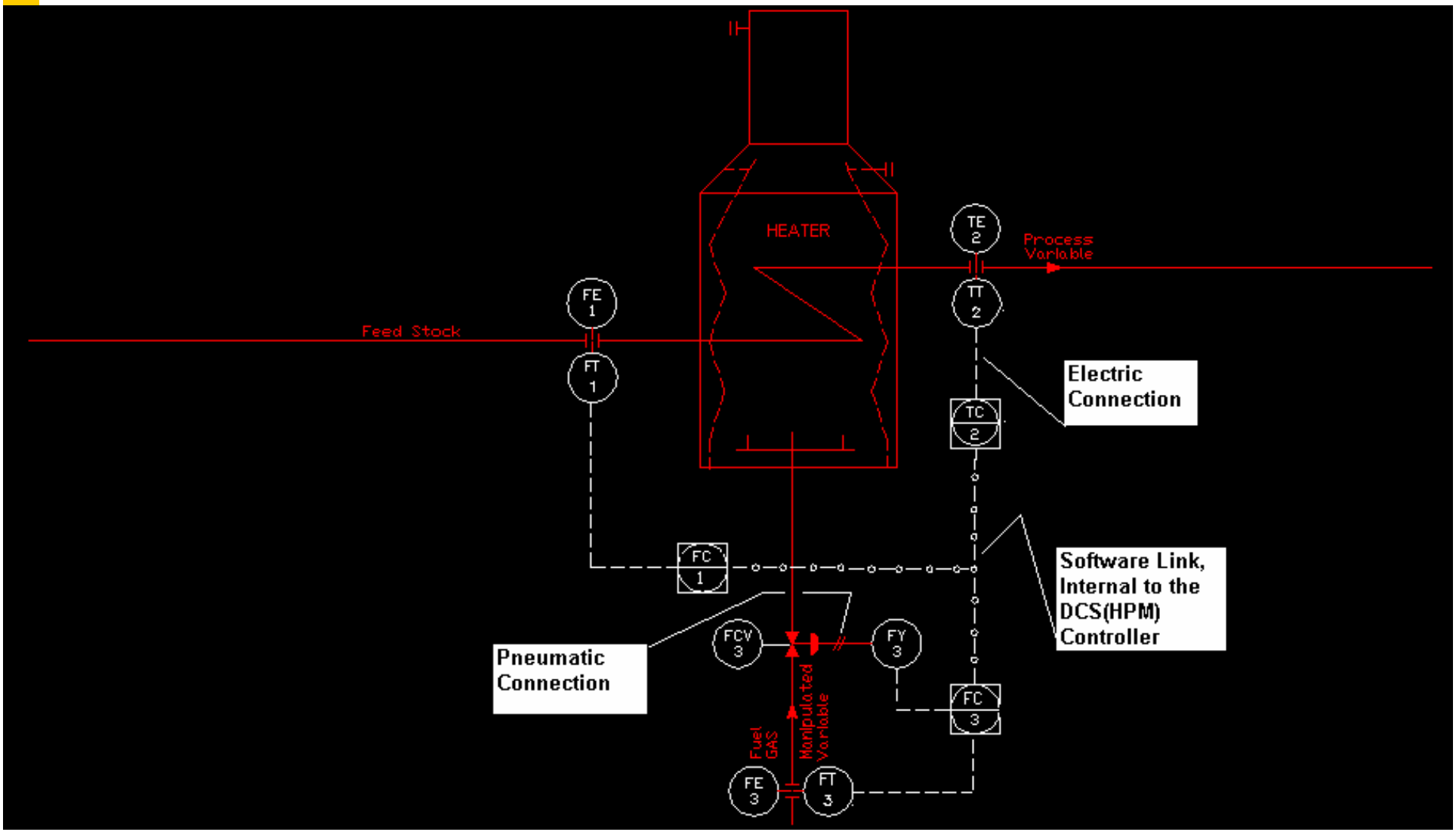
Connection Types, Sheet 2

Solid Line With X Shapes.
Denotes A Capillary Tube.
(Such As Remote Sealed Pressure Differential Transmitters)

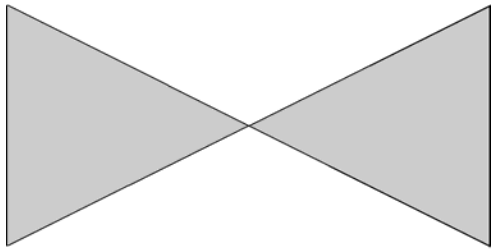


Solid Line With L Shapes.
(Denotes A Hydraulic Signal Or Process.)

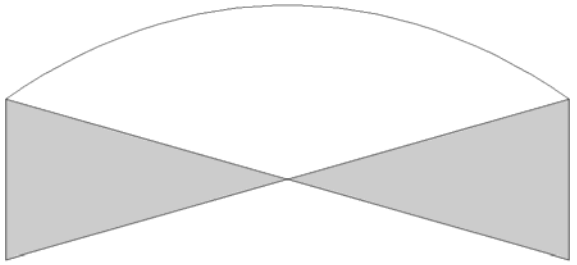
Connection Types in P&ID View



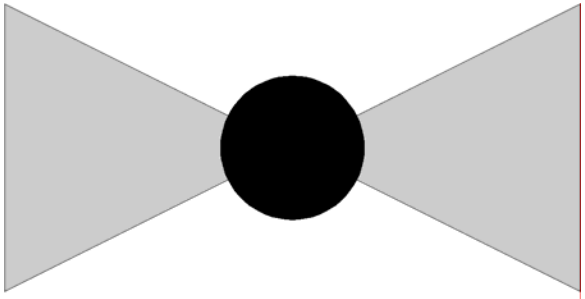
Valve Symbols, Sheet 1



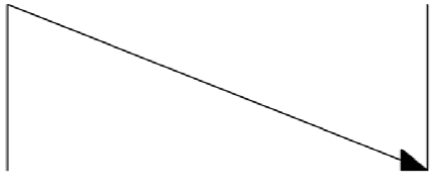
General Valve Symbol.



Diaphragm Valve Symbol.

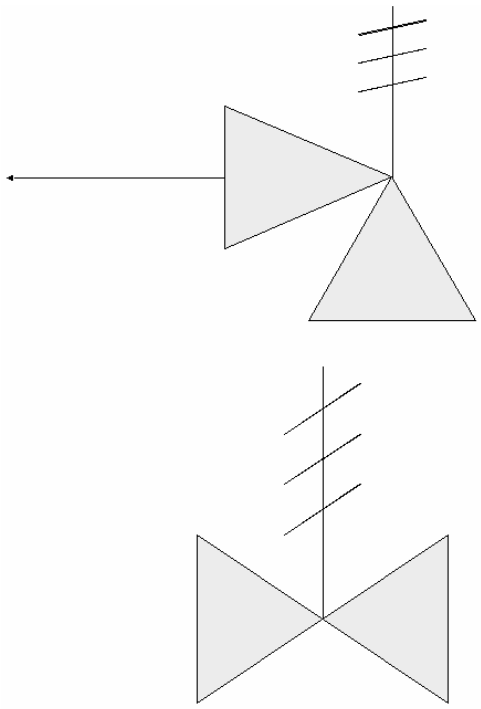


Globe Valve Symbol.

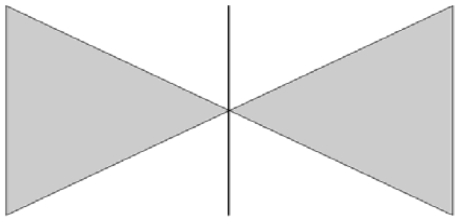


Check Valve Symbol.

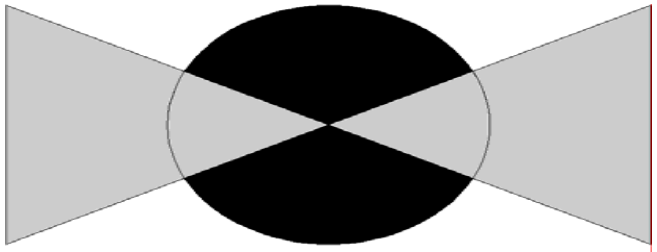
Valve Symbols, Sheet 2



Pressure Safety or Relief Valve Symbols.

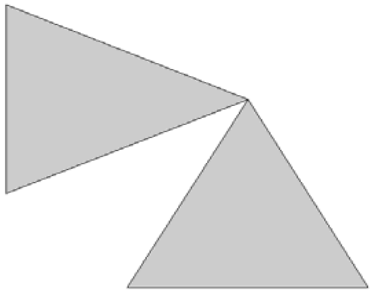


Gate Valve Symbol.

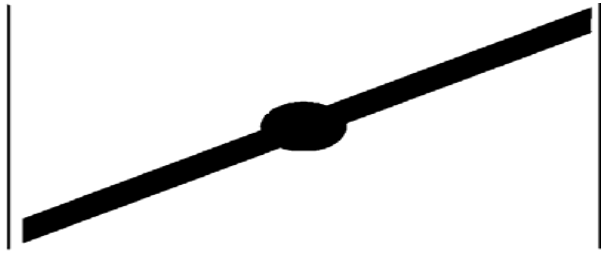


Ball or Rotary Valve Symbol.

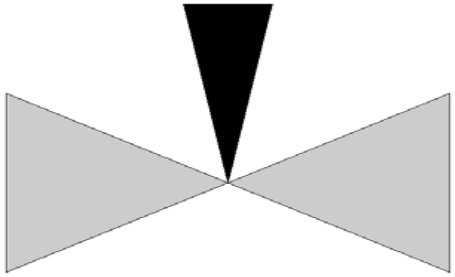
Valve Symbols, Sheet 3



Angle Valve Symbol.

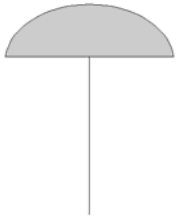


Butterfly Valve Symbol.

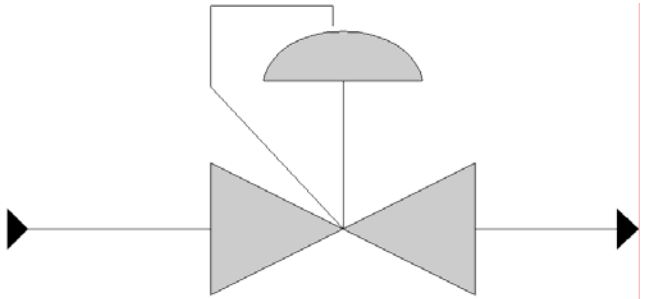


Needle Valve Symbol.

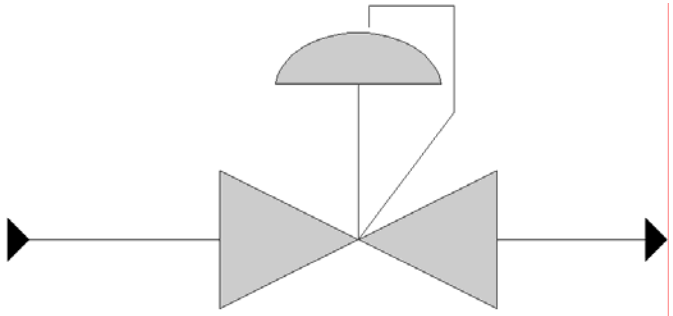
Valve Symbols, Sheet 4



Diaphragm Actuator Symbol.

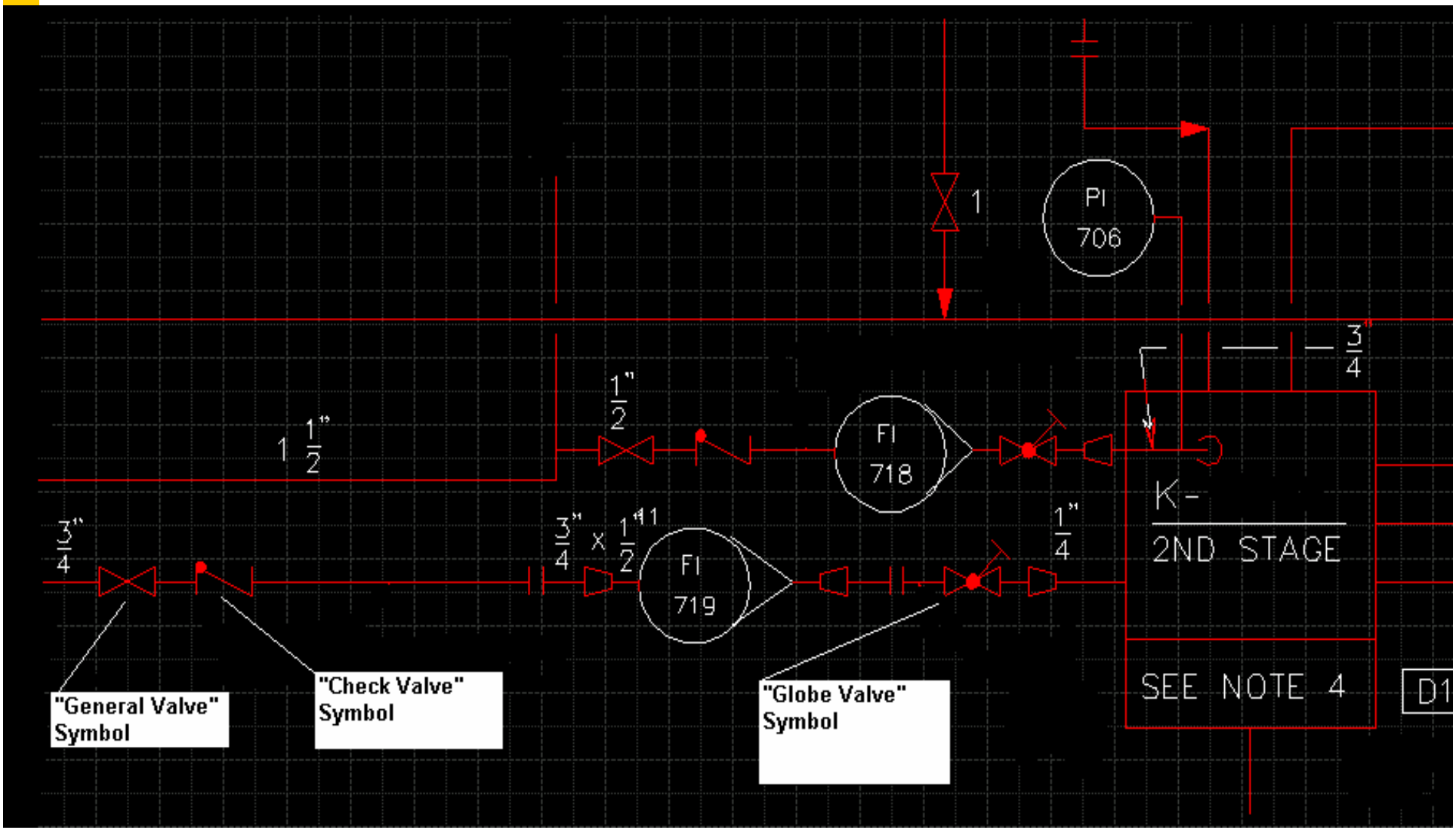


Self Contained Back-Pressure Regulating Valve Symbol.

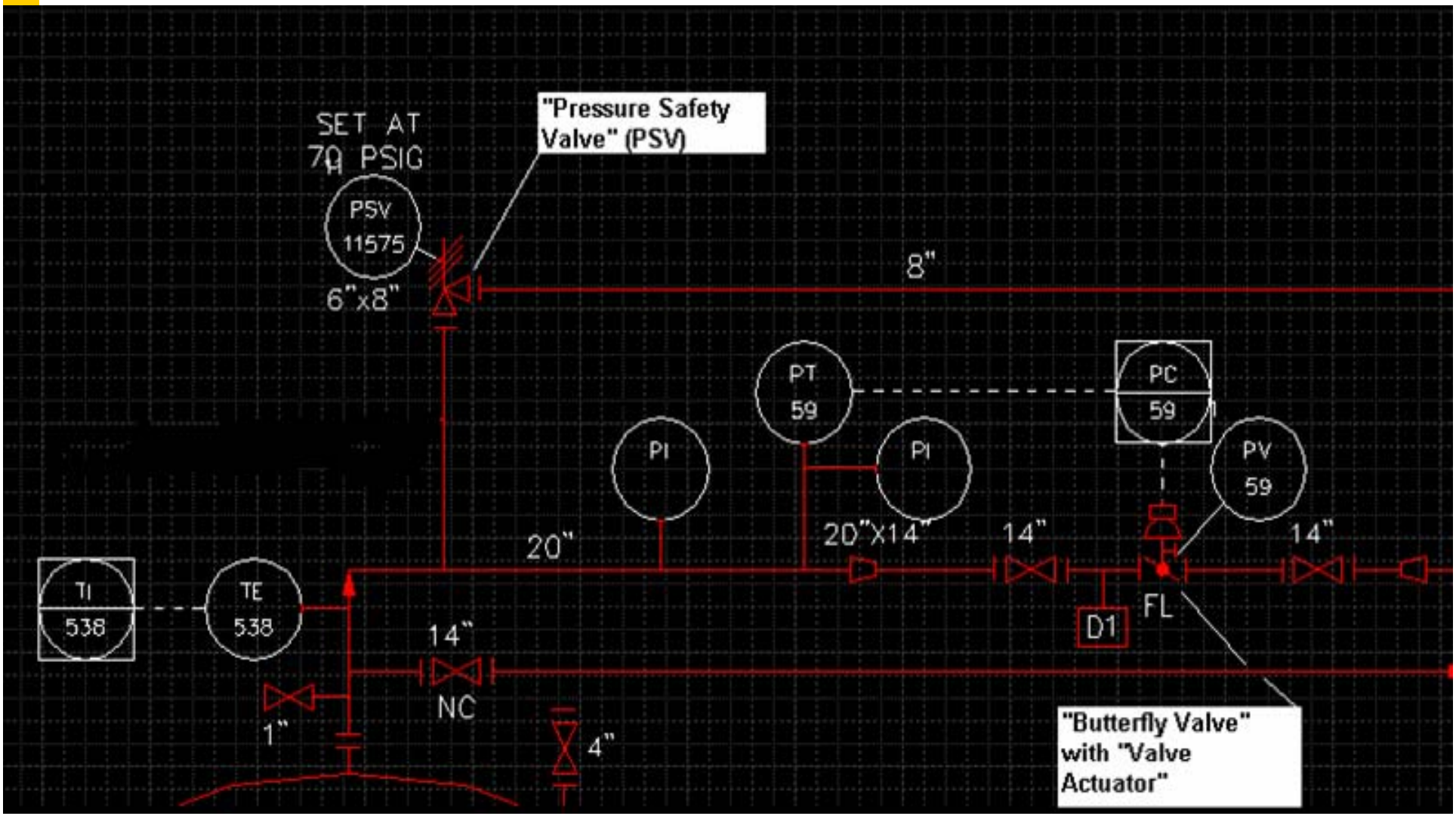


Self Contained Pressure Reducing Valve Symbol.

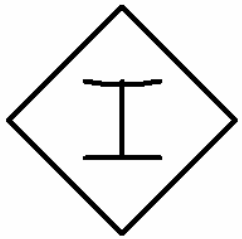
Valve Symbols in P&ID View



Valve Symbols in P&ID View

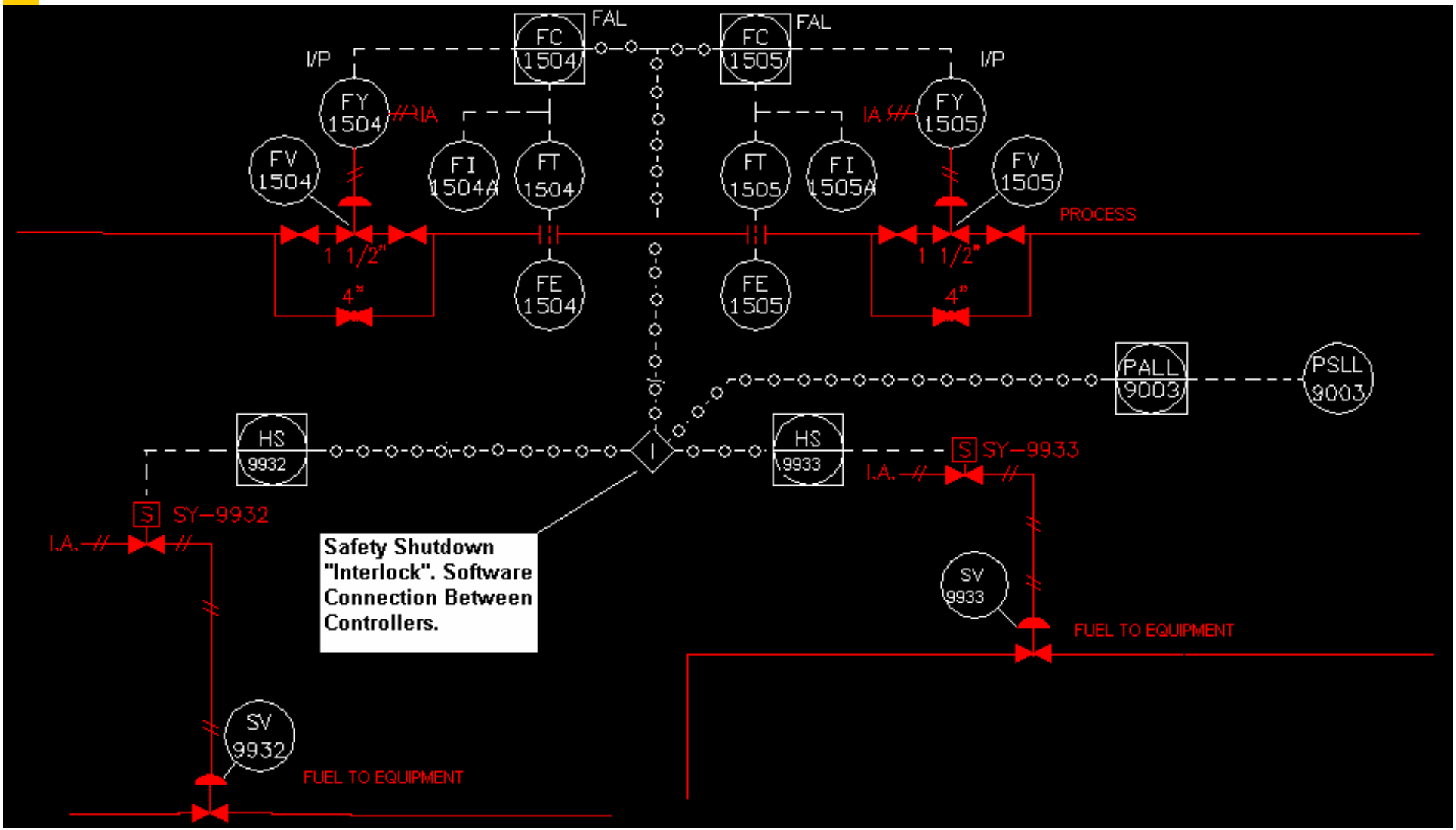


Interlock Symbol



InterLock Symbol.
(With Modern Controls,
Usually Software Logic
Built-in The Controller.)

Interlock Symbol in P&ID View

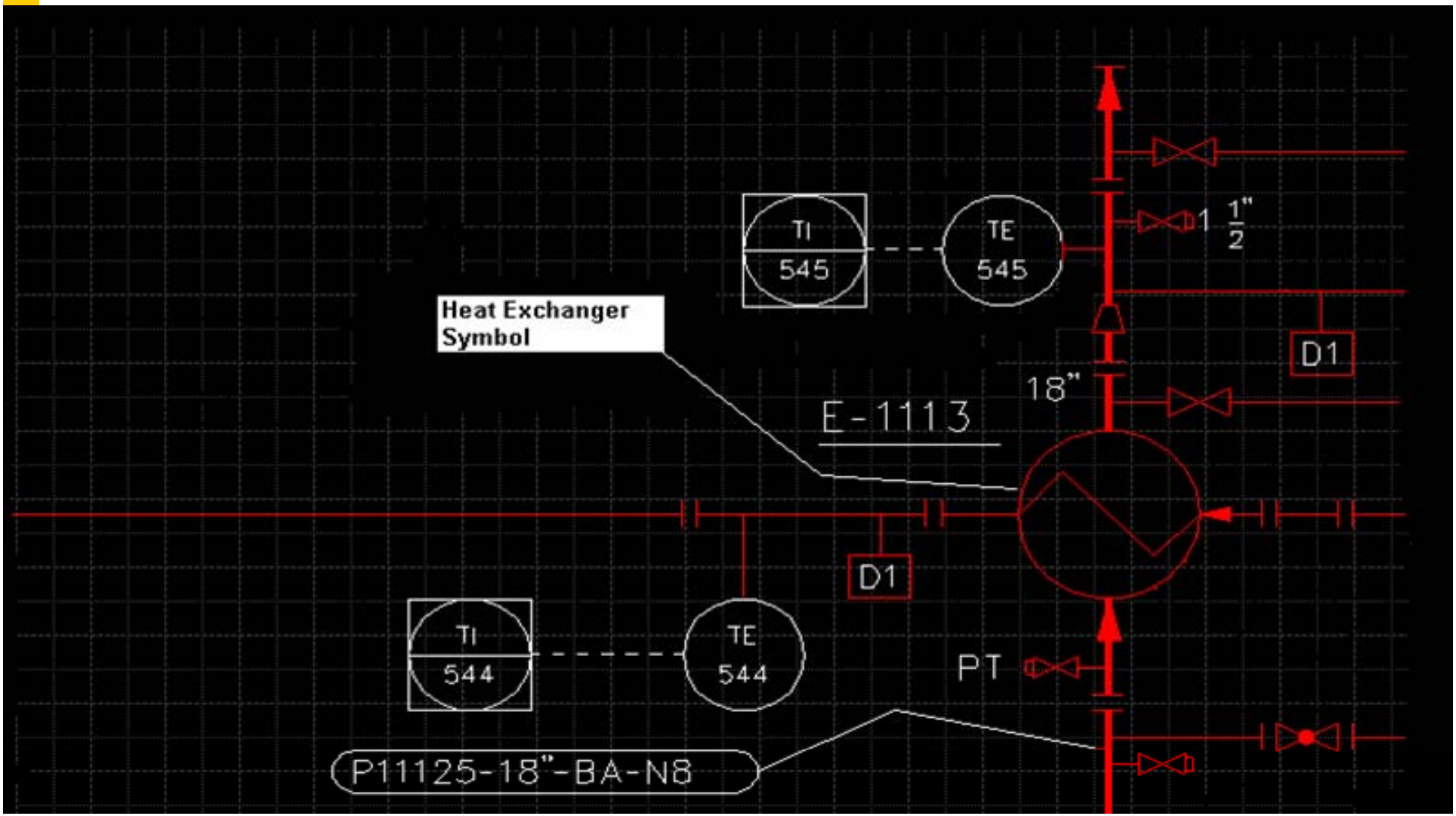


Equipment Symbols

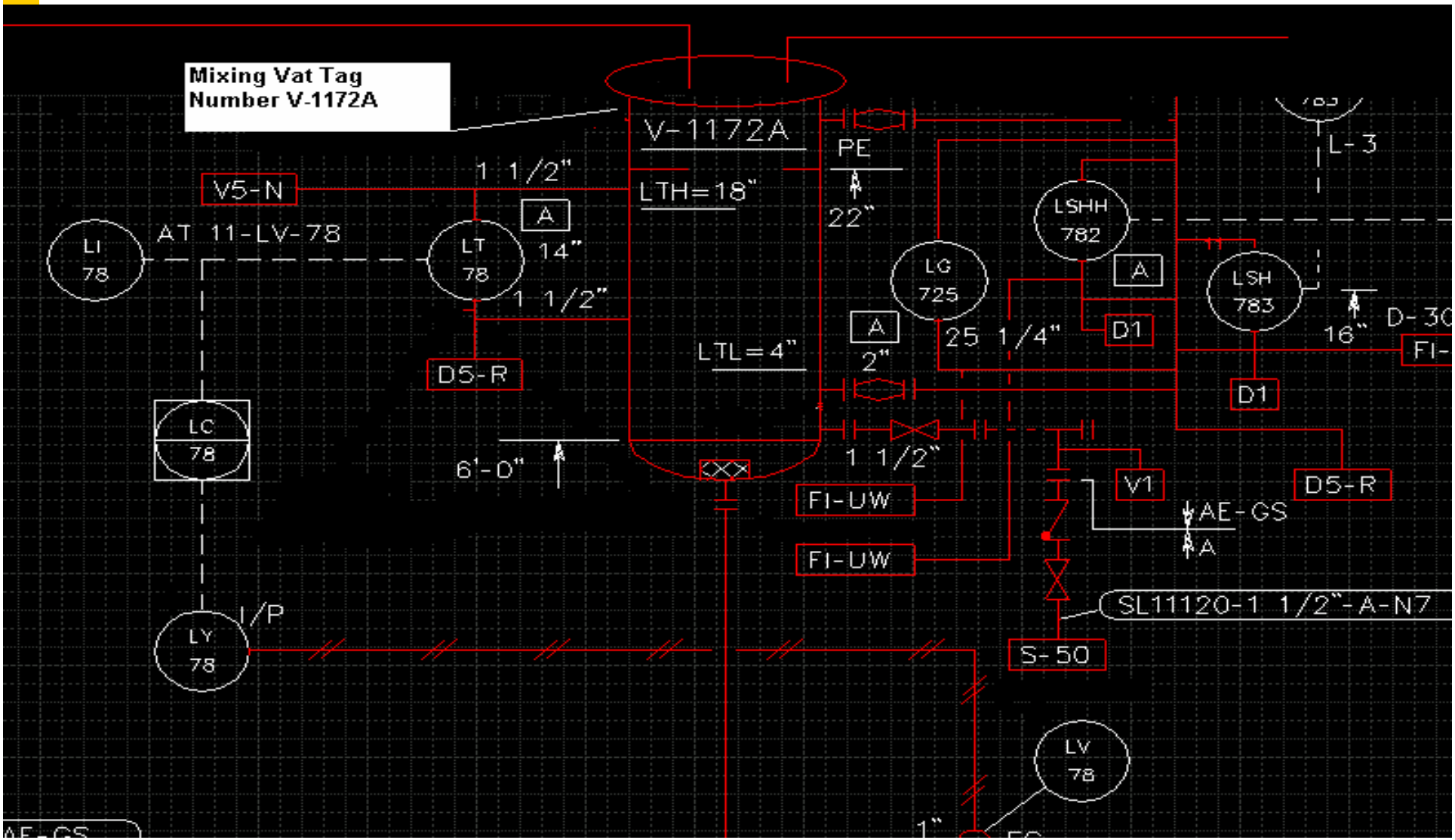
Process Equipment Symbols such as pumps, heaters, vessels, towers, fans, etc., are not addressed in the ISA Standards. ISA Standards address "Instrument and Controls" Symbols only. When working with Process Equipment Symbols, the symbol tables to be used are generally client specific. You, the controls engineer or Honeywell employee, should be familiar with the clients symbols.

As a general rule, the symbols used for Process Equipment are somewhat similar client to client. The following are examples of equipment as they might appear.

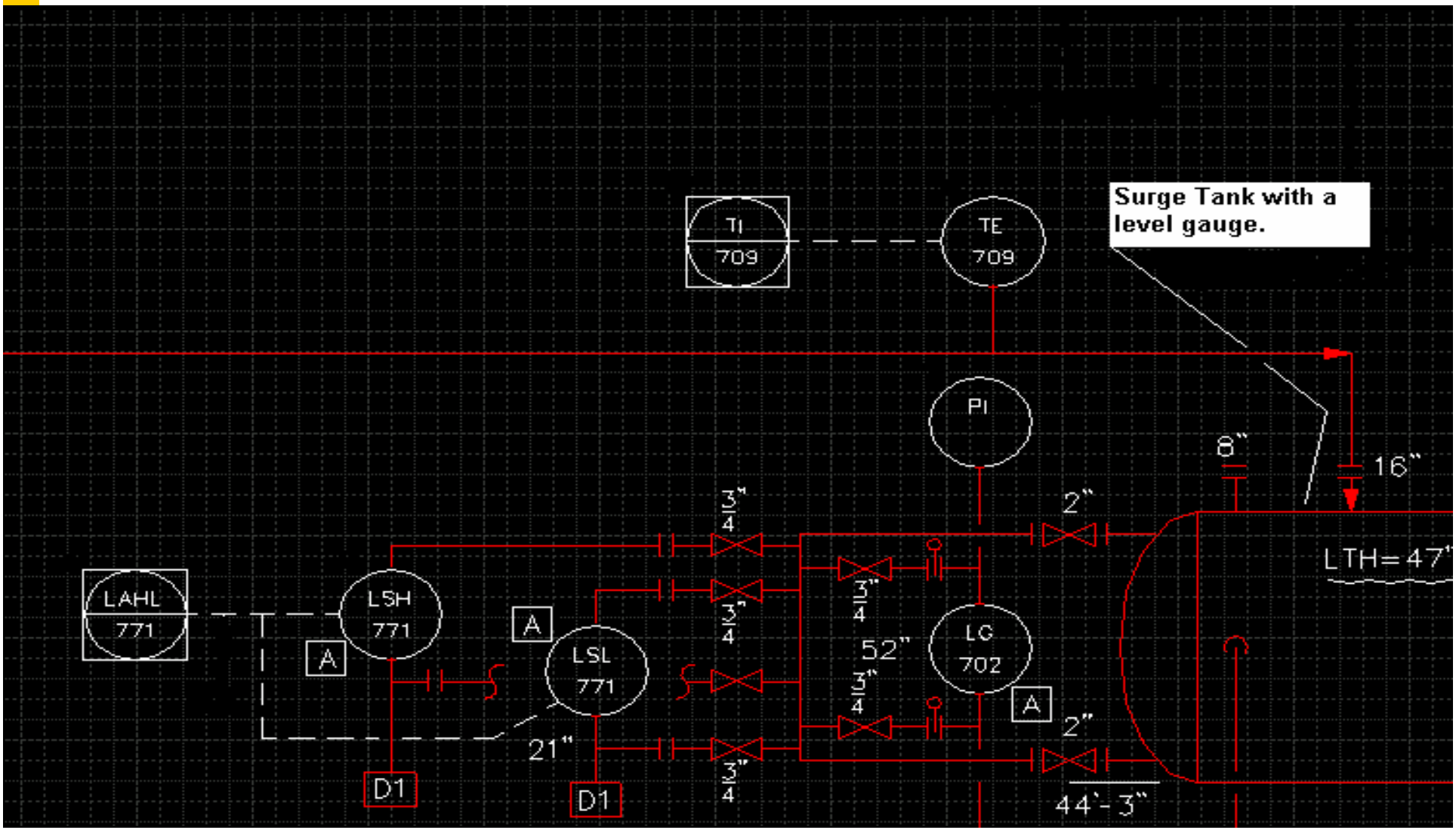
Equipment in P&ID View



Equipment in P&ID View



Equipment in P&ID View



ISA Tagging Convention

- The ISA tagging convention for instruments follows a specific format concerning what each letter in the “TAG” represents. The following tables taken from ISA define what each letter should mean and how the “TAG” is developed based on the function of the device.

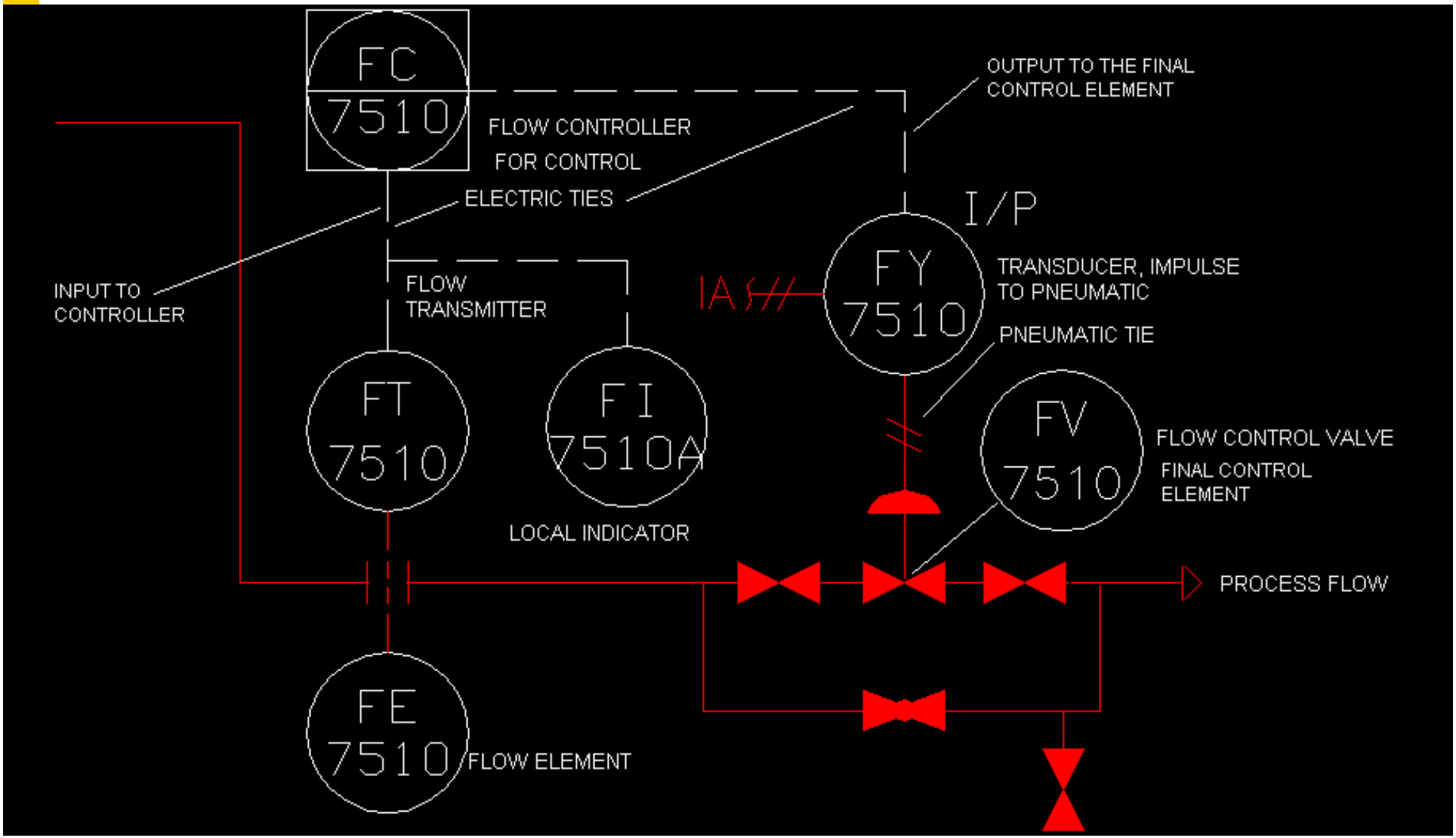
ISA Instrument I.D. Letters, A thru M

Instrument Identification Letters						
	First Letter	***Succeeding Letters***				
	Measures/Initiating Variable	**Modifier**	**Readout**	**Output**	**Modifier**	**Remarks**
A	Analysis		Alarm			
B	Burner (Combustion)		Users Choice	Users Choice	Users Choice	
C	Users Choice			Control		
D	Users Choice	Differential				
E	Voltage		Sensor			
F	Flow Rate	Ratio				
G	Users Choice		Glass Viewing Device			
H	Hand				High	
I	Current (Electric)		Indicate			
J	Power	Scan				
K	Time	Time Rate of Change		Control Station		
L	Level		Light		Low	
M	Users Choice	Momentary			Middle or Intermediate	

ISA Instrument I.D. Letters, N thru Z

	Instrument Identification Letters					
	First Letter	***Succeeding Letters***				
	Measures/Initiating Variable	**Modifier**	**Readout**	**Output**	**Modifier**	**Remarks**
N	Users Choice		Users Choice	Users Choice	Users Choice	
O	Users Choice		Orifice			
P	Pressure or Vacuum		Point or Test Connection			
Q	Quantity	Integrate or Totalizer				
R	Radiation		Record			
S	Speed or Frequency	Safety		Switch		
T	Temperature			Transmit		
U	Multivariable		Multifunction	Multifunction	Multifunction	
V	Vibration, Mech. Analysis			Valve, Damper, Louver		
W	Weight, Force		Well			
X	Unclassified	X Axis	Unclassified	Unclassified	Unclassified	
Y	Event, State or Presence	Y Axis		Relay, Comput or Convert		
Z	Position, Dimension	Z Axis		Driver, Actuator		

ISA I.D. Letters in P&ID View



ISA Letter Combinations

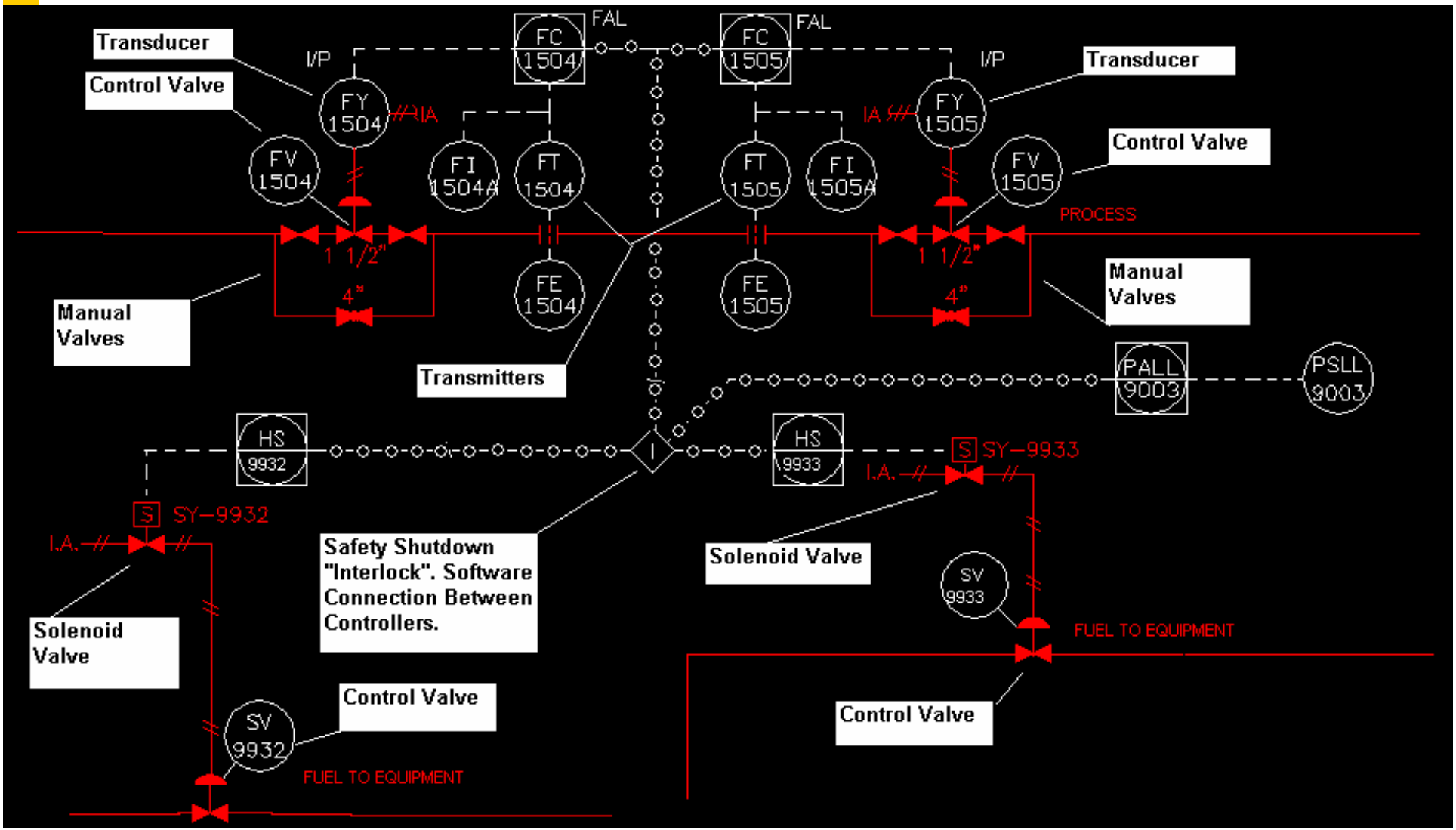
Typical Letter Combinations		
Tag Name	***Definition***	***Remarks***
FIC	Flow Indicating Controller	Software Point
FIT	Flow Indicating Transmitter	Field Device
FSH	Flow Switch High	Field Device, Alarm
FSL	Flow Switch Low	Field Device, Alarm
LT	Level Transmitter	Field Device
LRC	Level Recording Controller	Software Point
LSHL	Level Switch High Low	Field Device, Alarm
PIT	Pressure Indicating Transmitter	Field Device
PC	Pressure Controller	Software Point
PSL	Pressure Switch Low	Field Device, Alarm
PDIT	Pressure Differential Indicating Transmitter	Field Device
PDIC	Pressure Differential Indicating Controller	Software Point
PDR	Pressure Differential Recorder	Control Room Device
TT	Temperature Transmitter	Field Device
TIT	Temperature Indicating Transmitter	Field Device
TI	Temperature Initcator	Field Device
TCV	Temperature Control Valve	Field Device

4. How is the P&ID utilized?

By The Client

1. **The plant operators will use the P&ID as a quick reference for equipment and device locations with-in the process flow.**
2. **The process engineers will use the P&ID for reviews to determine system enhancements and modifications to the process flow and Process Control schemes.**
3. **The maintenance groups will use the P&ID for establishing maintenance schedules and device counts.**

P&ID use by the Client

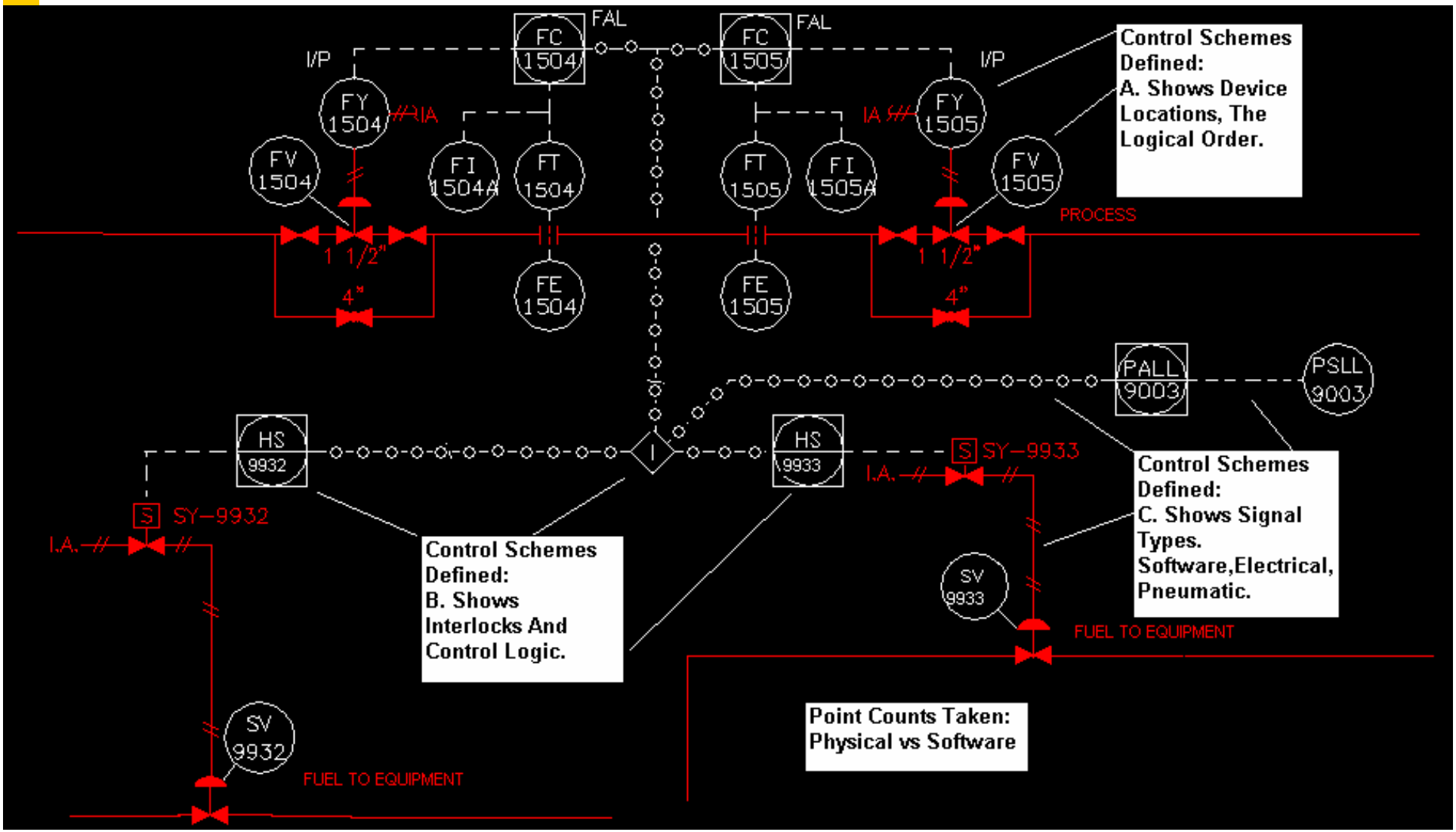


4. How is the P&ID utilized?

By Honeywell IAC

1. **Defines the control scheme**
   - **A. Shows the location of all devices within a control loop**
   - **B. Interlocks and Control Logic**
   - **C. Electrical vs. Pneumatic signals**
2. **Point counts for estimating purposes**

P&ID use by Honeywell

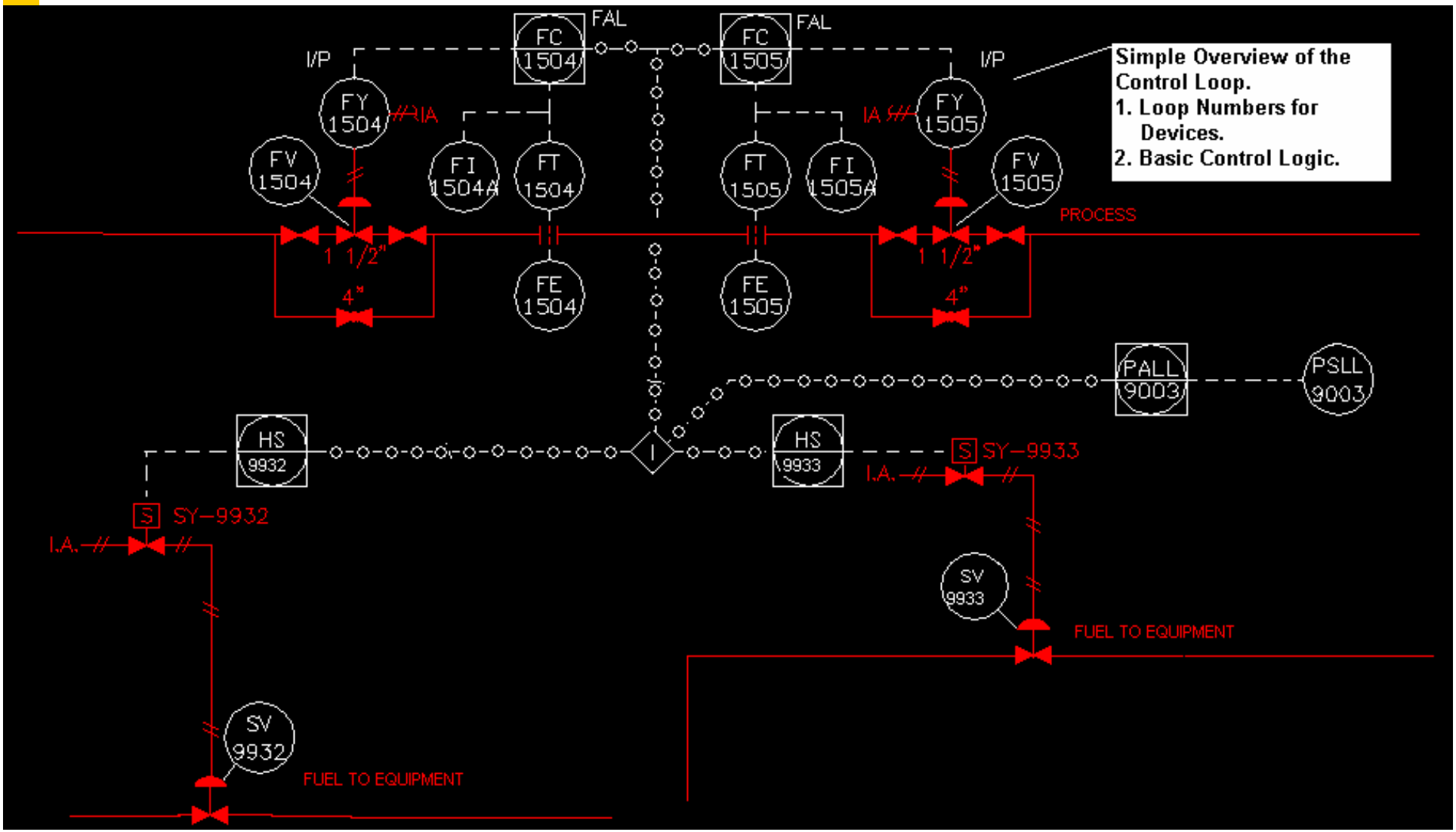


5. How the P&ID works with "LOOP Diagrams"

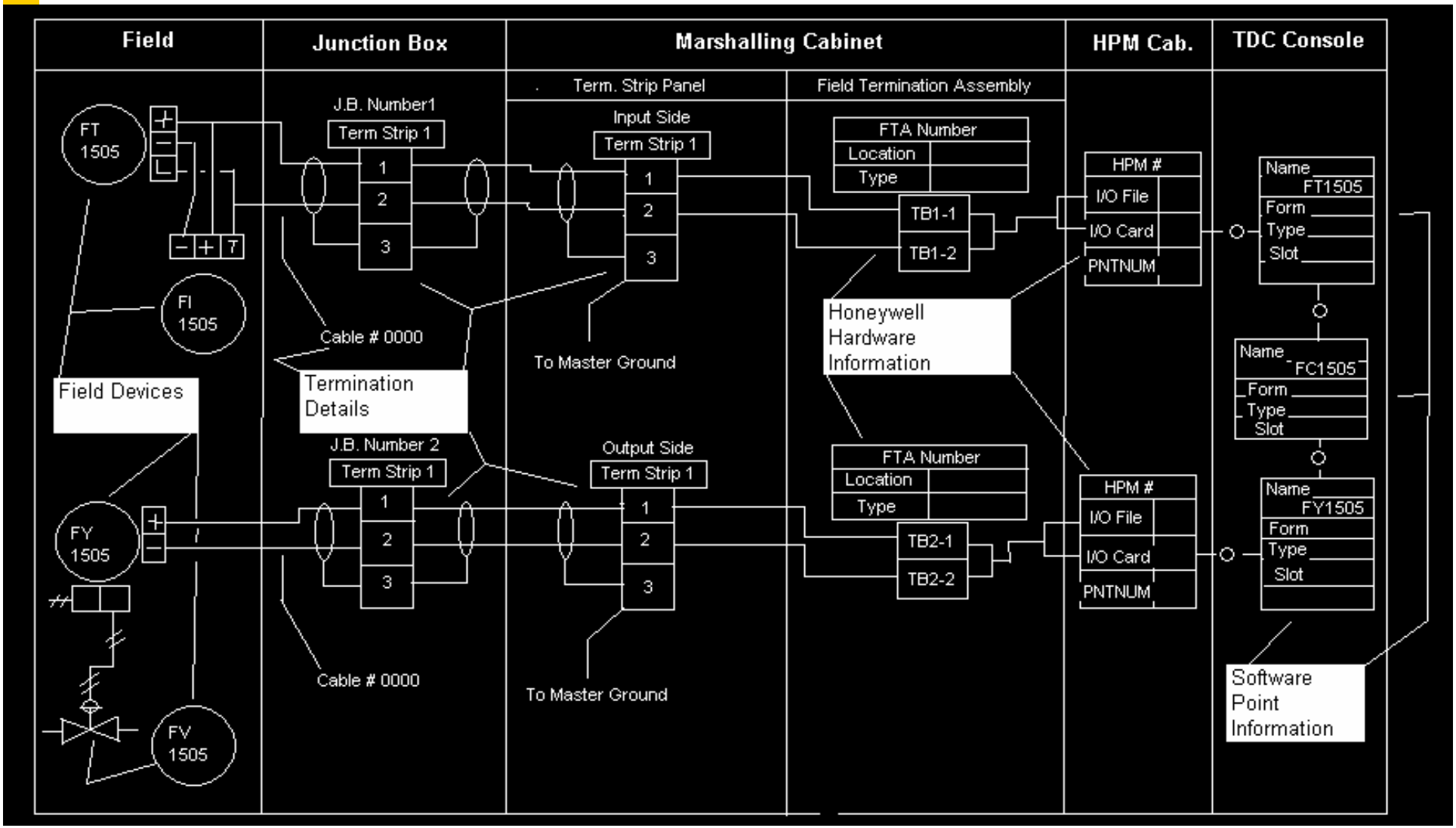
A. It provides a simple overview of the control loop with loop numbers and basic logic.

B. It references the reviewer to the applicable loop diagram where specific loop and installation detail can be found.

Loop Information Shown on the P&ID



Loop Information Shown on the Loop Diagram



End

- You have reached the end of this online training.