TECHNICAL PRESENTATION
ON

“Piping & Instrumentation Diagrams”

PRESENTED BY

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A Typical Chemical Plant

Chemical Process Diagrams

(Flow sheets)

- Engineering drawings that defines the Chemical Process Steps in proper sequence Pictorially
- More elaborate diagrammatic representations of Equipments, Sequence of Operations, and Performance of a Plant
- Necessary for clarity and to meet the needs of various persons engaged in Design, Cost estimating, Purchasing, Fabrication, Operation, Maintenance and Management
- During plant design, for understanding the process requirements
- During Operations, forms a basis for comparison of operating performance with design
- Can be used by operating personnel for the preparation of operating manuals and training

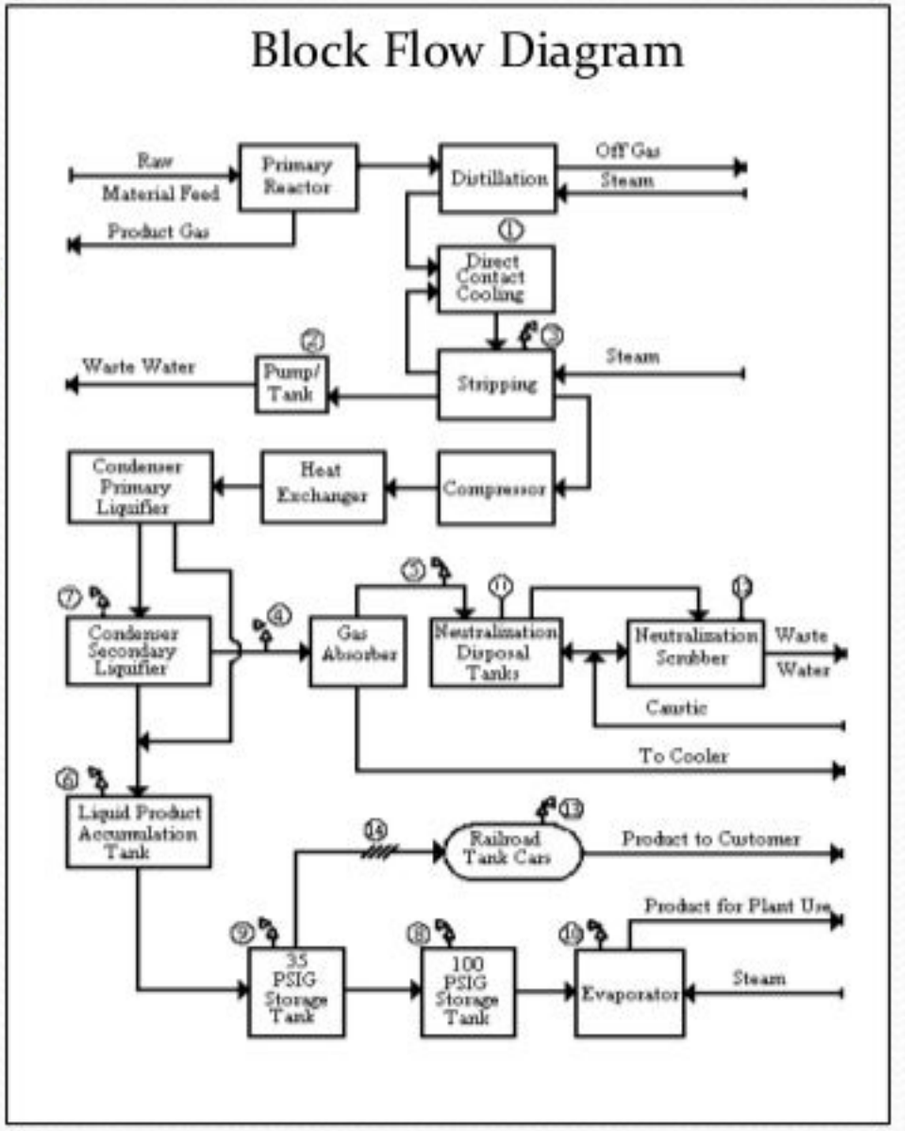
➡ **Key documents in understanding Process, during Operation and Maintenance**

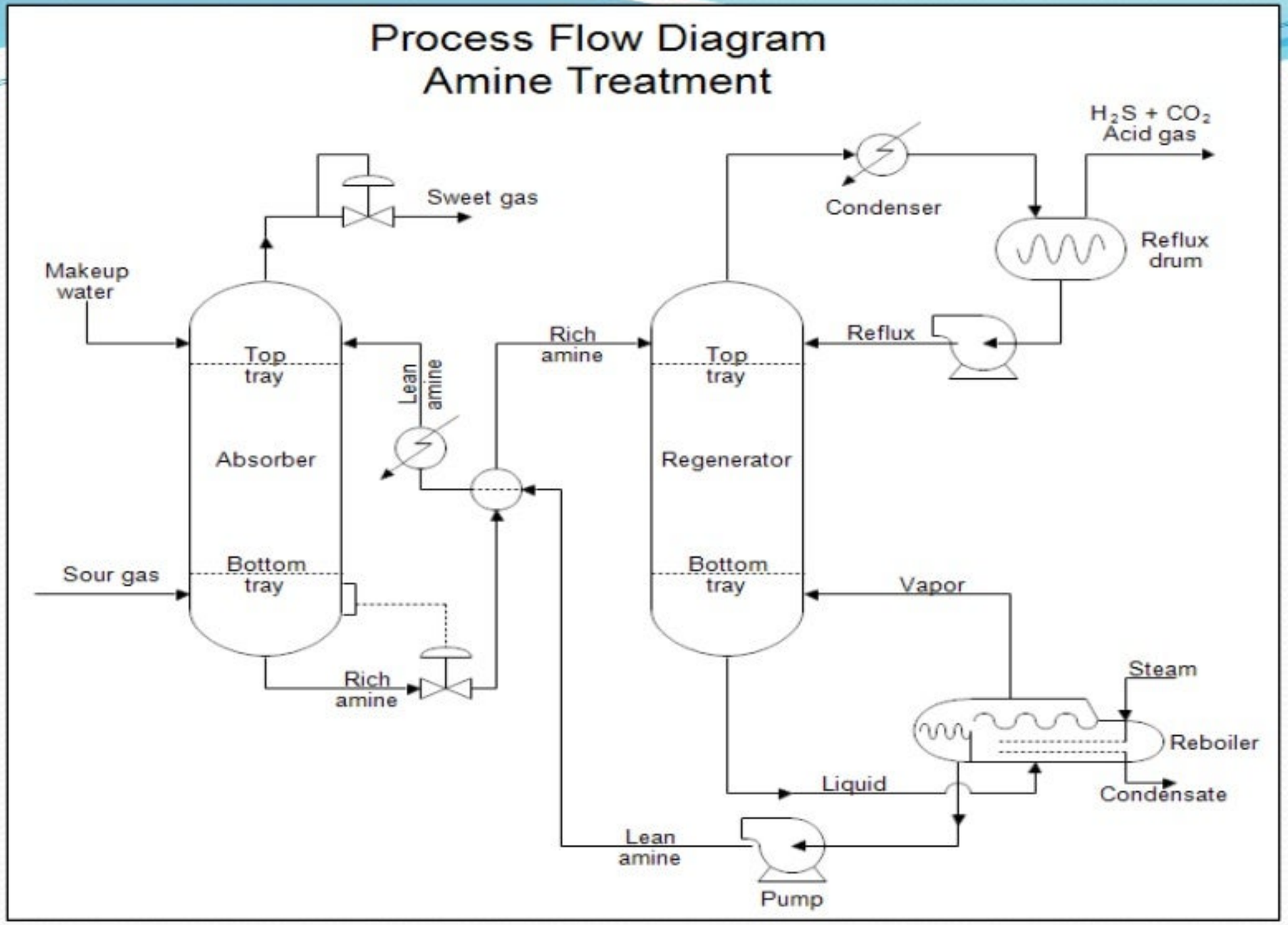
Types of Chemical Process Diagrams

- Block Flow Diagrams (BFDs)
- Process Flow Diagrams /Process Flowsheet (PFDs)
- Piping and Instrumentation Diagrams (P&IDs)
- Utilities Flow Diagrams (UFDs)

↓ Complexity Increases

↑ Conceptual Understanding Increases




Process Flow Diagram
Amine Treatment
$H_2S + CO_2$
Acid gas
Condenser
Sweet gas
Reflux
drum
Makeup
water
Rich
amine
Reflux
Top
tray
Lean
amine
Top
tray
Absorber
Regenerator
Sour gas
Bottom
tray
Bottom
tray
Vapor
Steam
Rich
amine
Reboiler
Liquid
Condensate
Lean
amine
Pump

Introduction to P&ID

- Diagram in the process industry which shows the Piping of the process flow together with the installed Equipment and Instrumentation

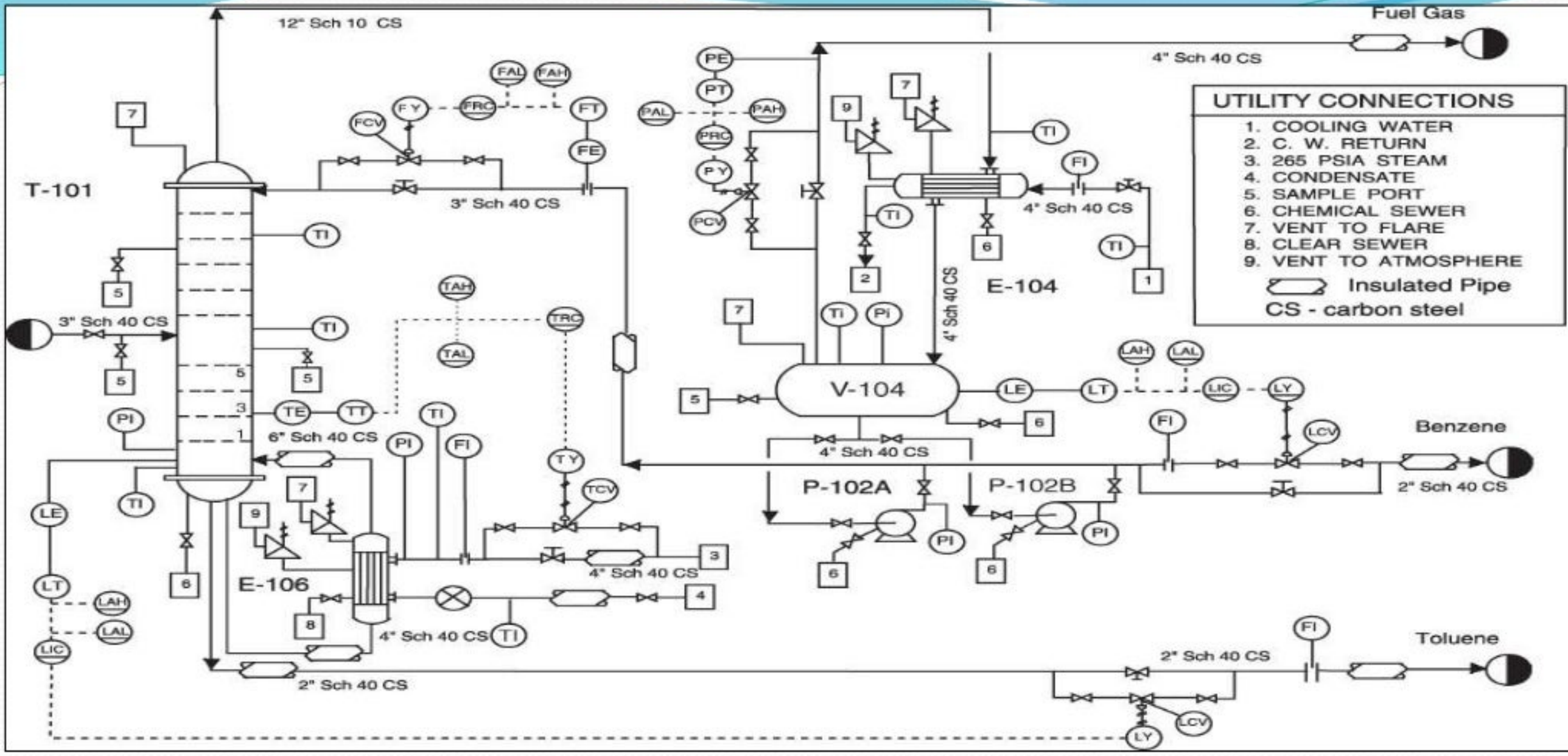
- Institute of Instrumentation and Control (UK) defines as-
" A diagram which shows the interconnection of Piping, Process Equipment and the Instrumentation used to control the process "

- In simple words, Schematic representation of all Equipment, Piping and Process Instrumentation

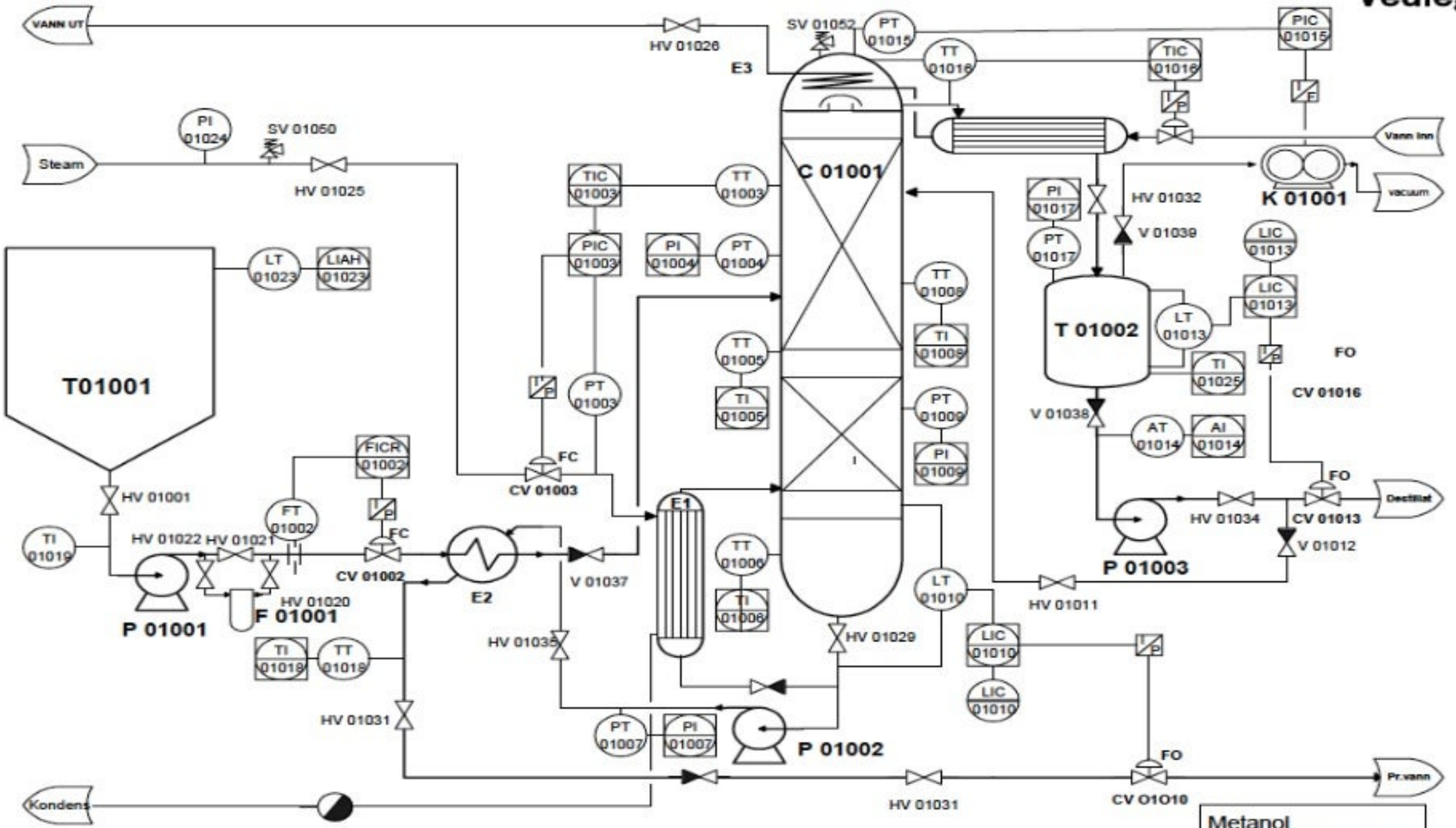
- Provides the basis for the development of system control schemes, allowing for further safety and operational investigations , such as HAZOP

- P&ID is used during most plant activities such as-
  - Normal operating conditions
  - Startup & Shutdowns
  - Regular Maintenance
  - Emergency Situations

"Piping & Instrumentation Diagram"



Piping & Instrumentation Diagram



Metanol gjenvinningsanlegg
Anl. 01000

P&ID can be divided into 3 parts:

- Equipment Specification
- Instrument Specification
- Piping specification

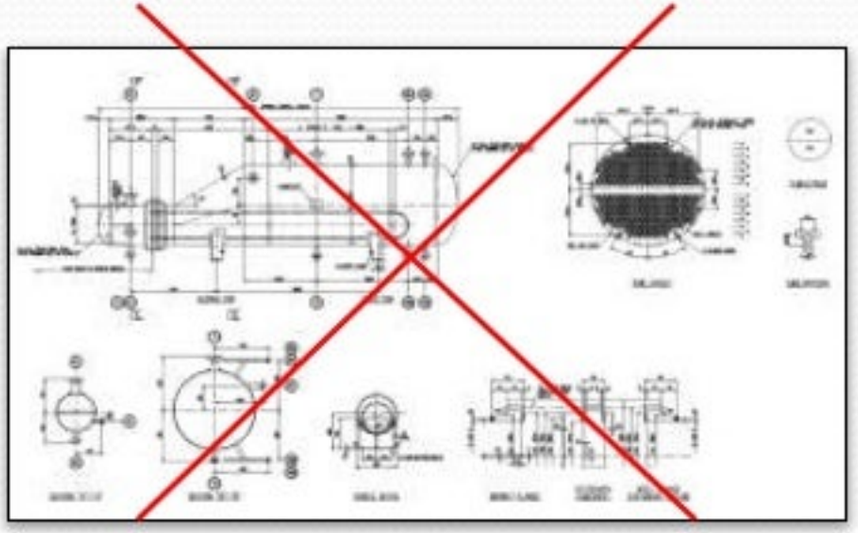
P&ID takes different form depending on:

- Nature of the Process
- Firm performing the design work
- Design Philosophy
- Intended Audience

Purpose of P&ID

- **To show –**
  - ✓ Material Flow
  - ✓ Piping between various sections
  - ✓ Major pieces of mechanical Equipments
  - ✓ Valves and directions of process flow
  - ✓ Field Mounted instruments
  - ✓ Electrical Equipments
  - ✓ Communication Links

- **Not to show-**
  - ⊘ Process Information
  - ⊘ Physical dimensions of equipment
  - ⊘ Piping Details
  - ⊘ Control Logic



P&ID Symbology

Standards and Codes used in Instrumentation-

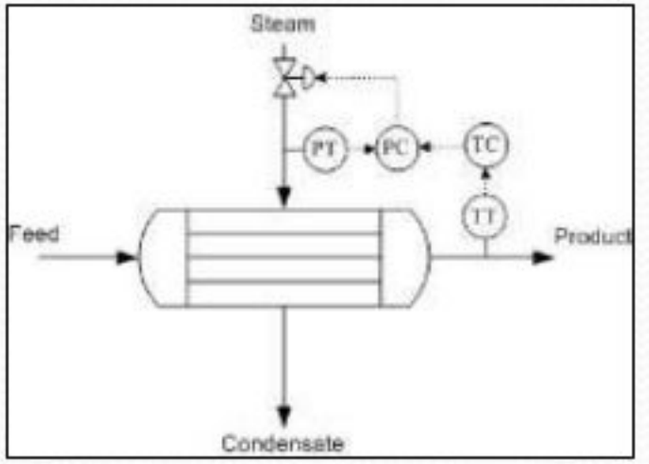
- American National Standards Institute (ANSI)- All Products & Services
- American Petroleum Institute (API)- Oil & Natural Gas
- American Society for Testing Materials (ASTM)- All Products & Services
- American Society of Mechanical Engineers (ASME)-Pressure vessels & Pipes
- American Institute of Chemical Engineers (AIChE)- Manufacturing Processes
- Deutsches Institut für Normung (DIN)- Rules and symbols for flow-sheet
- International Society of Automation (ISA)- Process control

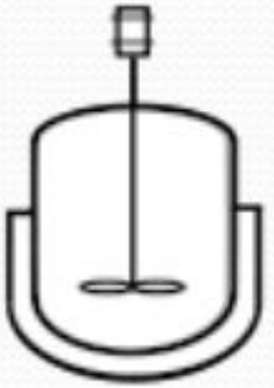
➡ **ANSI/ISA-S5.01-2009**

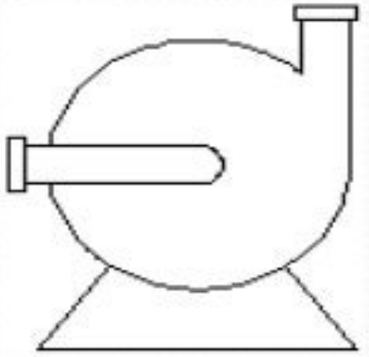
“ **Goal of uniformity in the field of Instrumentation** ”

P&ID Symbol Contents

- **Equipment Symbology**
  - Equipment Layout
  - Equipment Identification & Numbering
  - Nozzles
  - Miscellaneous
- **Piping Symbology**
  - Piping Layout
  - Line Identification
  - Line Continuation
  - Piping Components
  - Utility Piping
- **Instrument Symbology**
  - Instrument Layout
  - Instrument Identification
  - Interconnecting Piping
  - Instrument Piping
  - Instrument Control







Equipment Symbology

I) Equipment Layout

- **Relative Shape**

e.g. Spheres, Tanks, Columns, Pumps

- **Relative Orientation**

e.g. Horizontal, Vertical, Sloped

- **Relative Position**

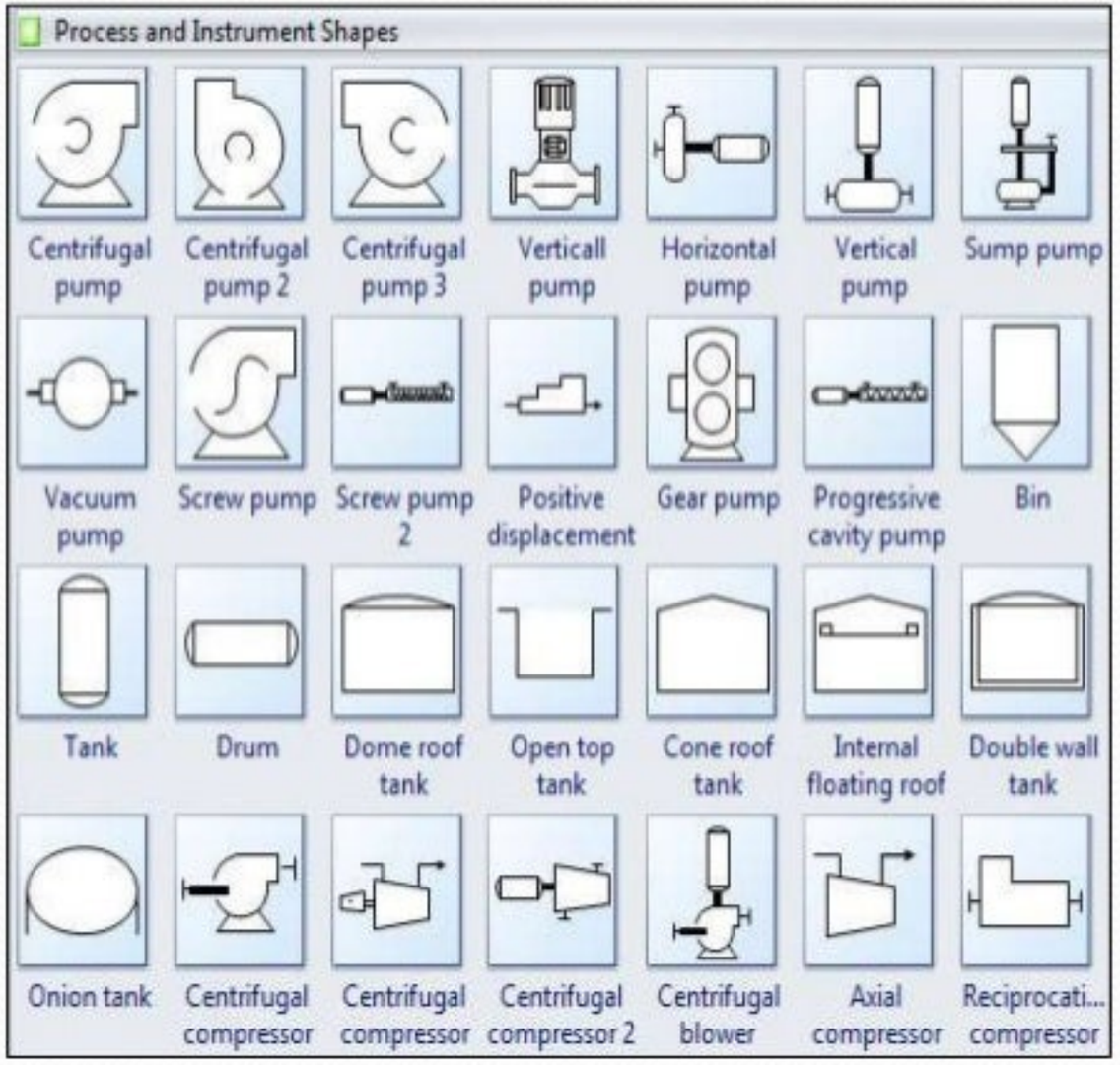
Location relative to other equipment

- **Relative Size**

Size relative to other equipment

- **Equipment Status**

e.g. New, Existing, Relocated, Future, Vendor S.



II) Equipment Identification-1

a) Tag Prefix :

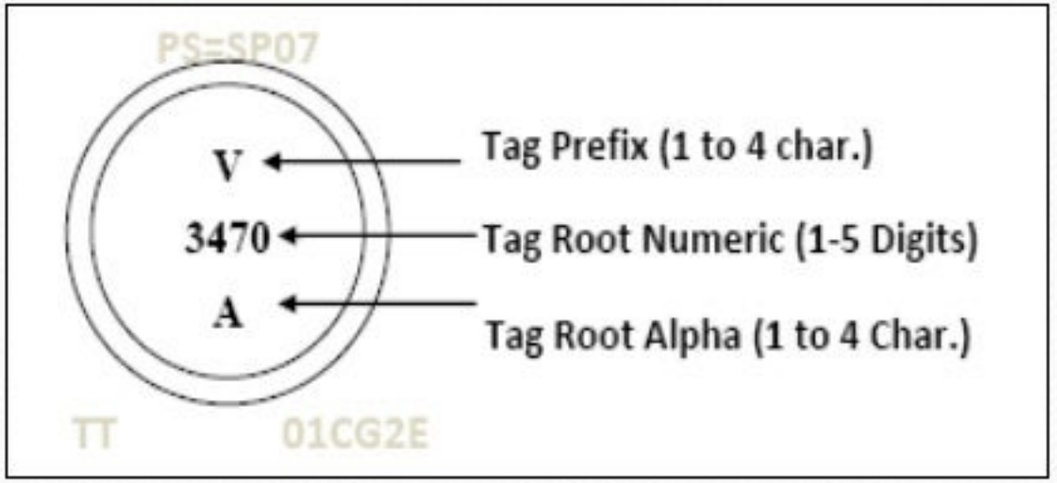
Shows type of the equipments
e.g. V- Storage tanks, P- Pump, FL- Filter ,CT- Cooling Tower

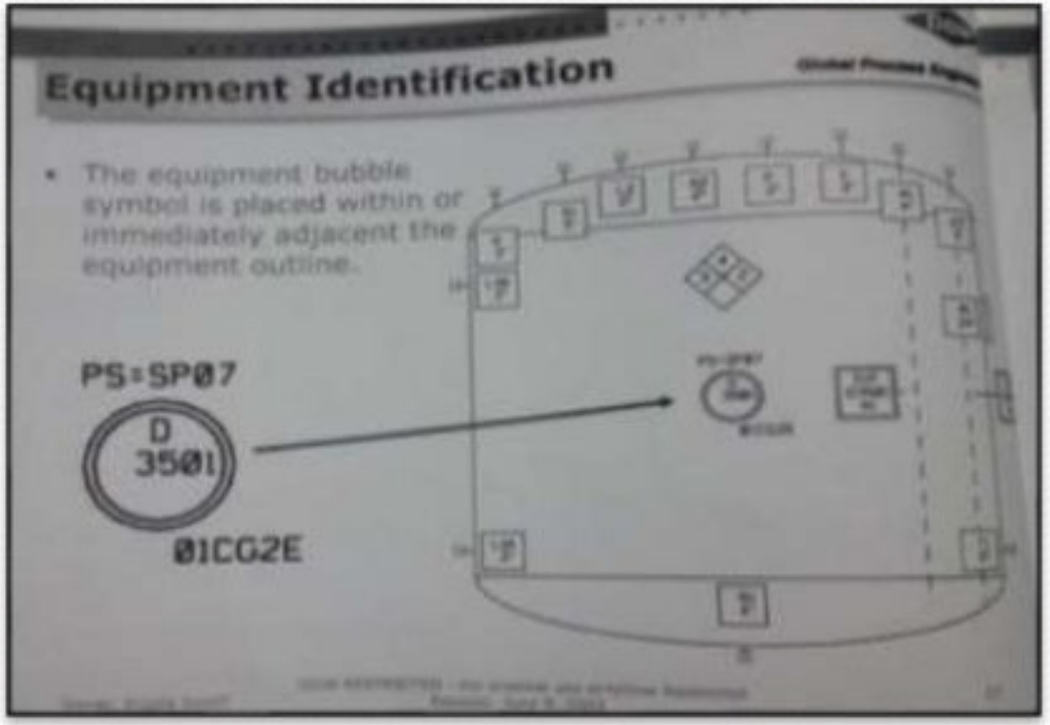
b) Tag Root Numeric :

Gives typical number to the equipment - Equipment Number
e.g. V-405, D-220

c) Tag Root Alphabetic:

When there are more than 1 equipment is used in single operation then it is given by 1-5 alphabetic letters.
e.g. V-405.A, V-405.B





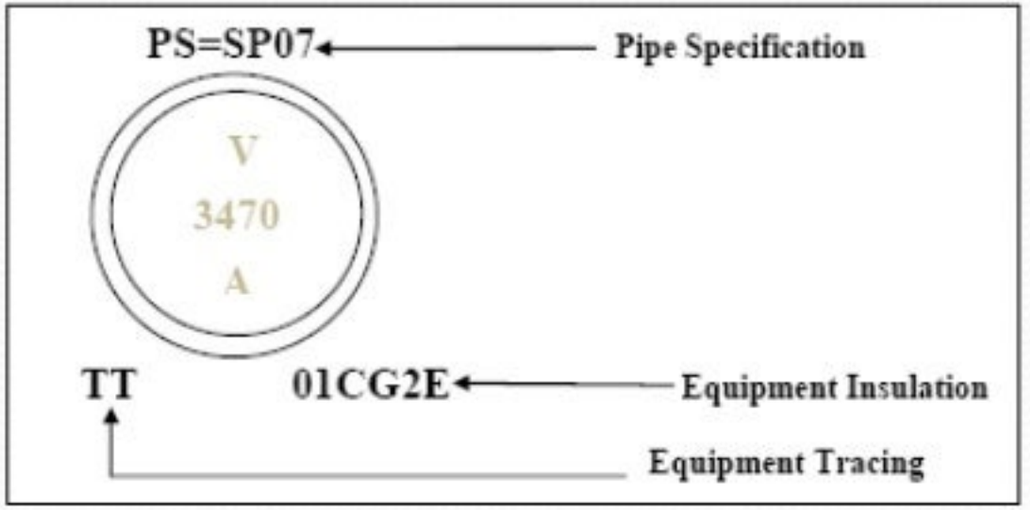
III)Equipment Identification-2

- Additional utilities used for its proper working are represented by some additional symbols outside the bubble.

- Equipment insulation and tracing is specified below the equipment bubble.

- Pipe specification to be used for piping trimming is specified above the equipment bubble symbol.

- Codes used to identify insulation, tracing and piping trim should be the same as used on the piping itself.



Equipment Numbering

P-1234

P- Equipment Prefix
1- Train number (optional)
2- Major area
3- Major unit operation in that area
4- Equipment within the unit operation

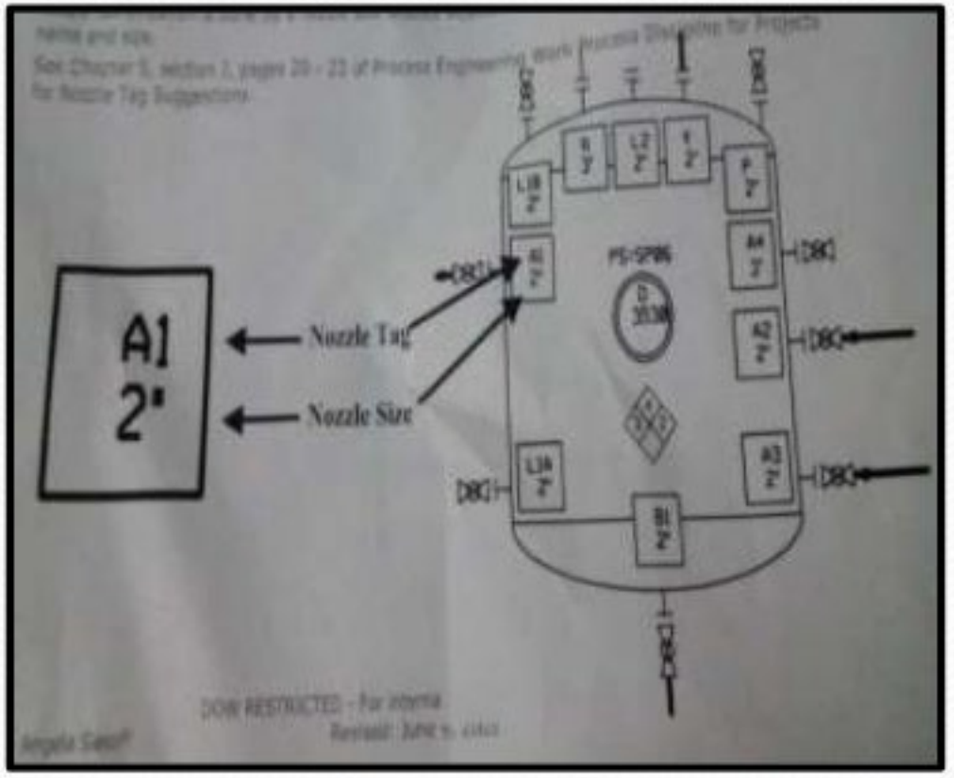
IV)Equipment Nozzles

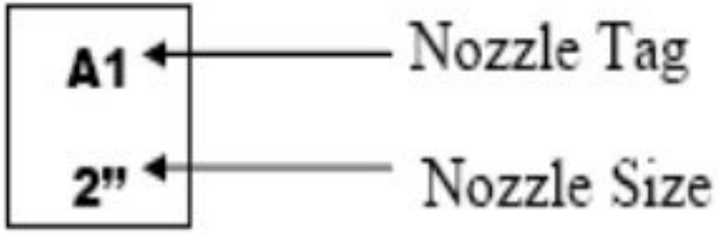
- Nozzle identification is done by a nozzle box located adjacent to the nozzle. It contains a unique name (tag) and size.

- Nozzle tag shows for which purpose the nozzle is used.
  e.g. A- Inlet, B- Outlet, L- Level Switch

- When there are more than 1 nozzles used for similar application, numbers are allocated to nozzles of similar type.
  e.g. L1, L2 - Level switches 1 & 2

- Number written below the nozzle tag inside the box shows size of the nozzle.
  e.g. In given case, size of the nozzle is 2 inches.





Nozzle Prefixes

Chapter 5, section J, pages 20 - 22 of Process Engineering Work Process Discipline for Projects

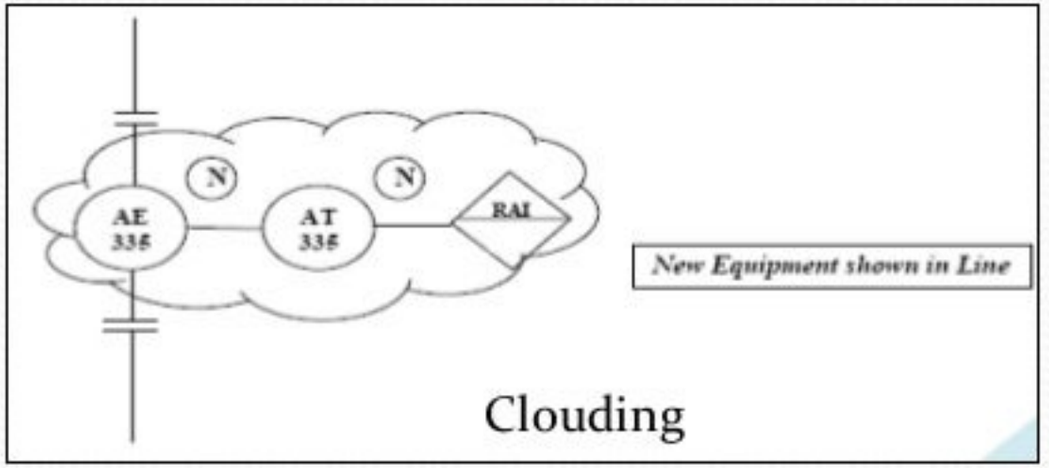
Service	Designation	Size
Inlet	A1, A2, A3, etc.	as required
Outlet	B1, B2, B3, etc.	as required
Agitator	C	10" or as required
Relief	R	as required (Consider one size larger)
Manway	M	24" minimum
Hand-hole	H	as required
Removable Baffle	RB (Glass Vessels)	8" minimum
Sample	Z	2"
Spare	S1, S2, S3, etc.	3" or 4" as required
Vent	V	2" minimum
Level Transmitter	L1, L2, L3, etc.	2" with drip ring
Level Trans. w/ 2 taps	L1A, L1B	lower tap A, and the upper tap B
Level Switch	L1, L2, L3, etc.	2" flanged
Pressure	P1, P2, P3, etc.	2" for non-plugging service, 3" w/ diaphragm
Press. Trans. w/ 2 taps	P1A, P1B	lower tap A, and the upper tap B
Temperature	T1, T2, T3, etc.	2"
Jacket Inlet	JA1, JA2, JA3, etc.	as required
Jacket Outlet	JB1, JB2, JB3, etc.	as required
Jacket Vent	JV1, JV2, JV3, etc.	1" flanged
Jacket Drain	JD1, JD2, JD3, etc.	1" flanged

DOW RESTRICTED - For internal use onlyDow Restricted

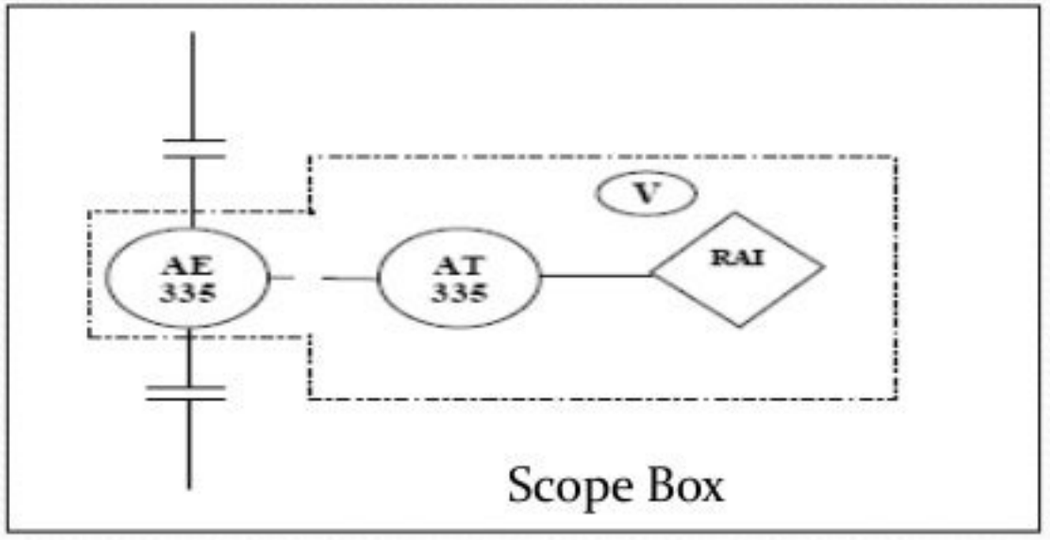
V) Item Status

- (N) - New
- (E) - Existing
- (R) - To be Relocated
- (V) - Vendor Supplied Packages
- (F) - Future
- (M) - To be Modified

VI) Clouding & Scope Box



Clouding



Scope Box

Piping Symbology

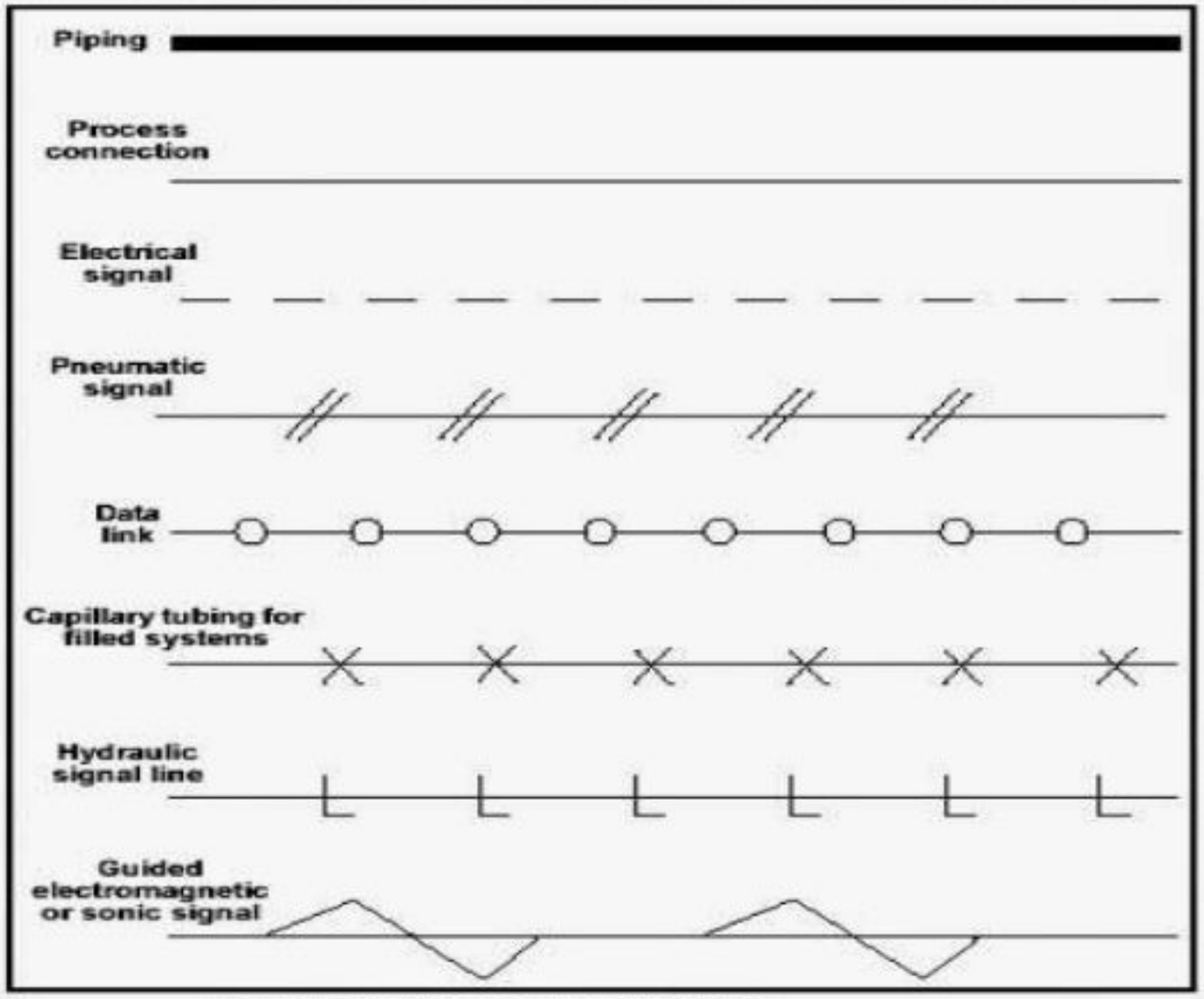
- Piping is shown schematically, in a logical sequence, not as it is actually piped in the field
- Piping specification differentiate between various piping systems
  e.g. pigging line system, cooling jacket pipeline etc.
- The various piping parts are shown according to following category:
  - Drains
  - Vents
  - Flush connections
  - Steam and Air traps
  - Reducers
  - Relief devices

- Each pipeline will have a label that gives a unique identifier, size and piping specification code
- Piping corrections to equipment, and line terminations are shown as flanged or threaded
- Piping length and elevation, isometrics, and stress considerations are not shown

Interconnecting Line types

Types of Connections:

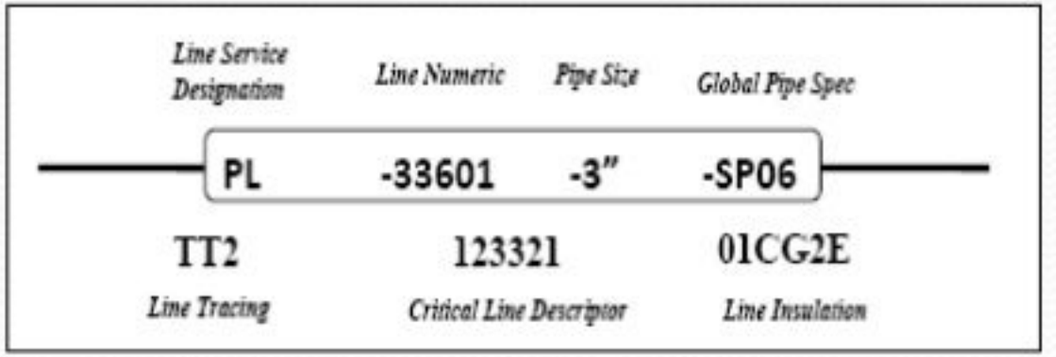
- Main Line(Pipeline)
- Process Connections
- Pneumatic Signals
- Data Links
- Capillary Tubing
- Hydraulic Signals
- Electromagnetic /Sonic Signal

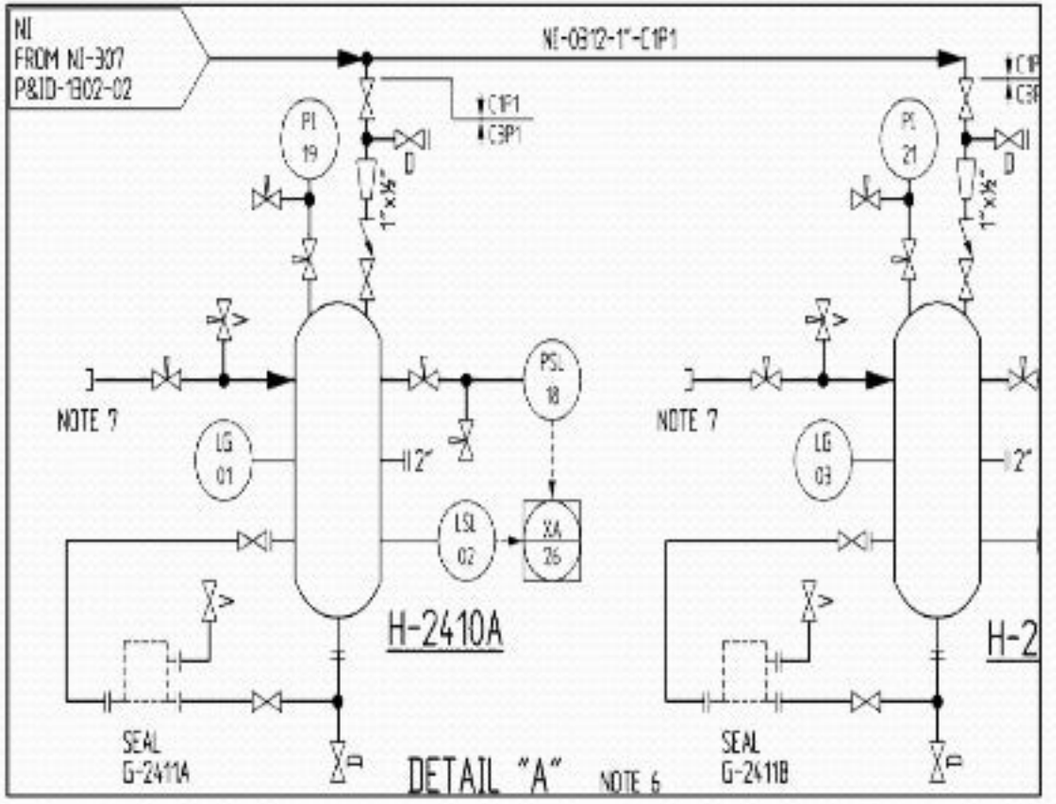


Piping and Connection Symbols

Line Identification

- Line Identification consists of the following information:
  - **Service Designation –** Type of fluid flowing through it
  - **Numeric Number** – Pipe line no. from the drawing
  - **Pipe size** – Outer diameter of the pipe
  - **Global Pipe Specification Code** – MOC of pipe
  - **Tracing Codes –** Type of tracing (if available)
  - **Insulation and Jacketing –**Type of Insulation /Jackets
  - **CLD** – Critical line descriptor



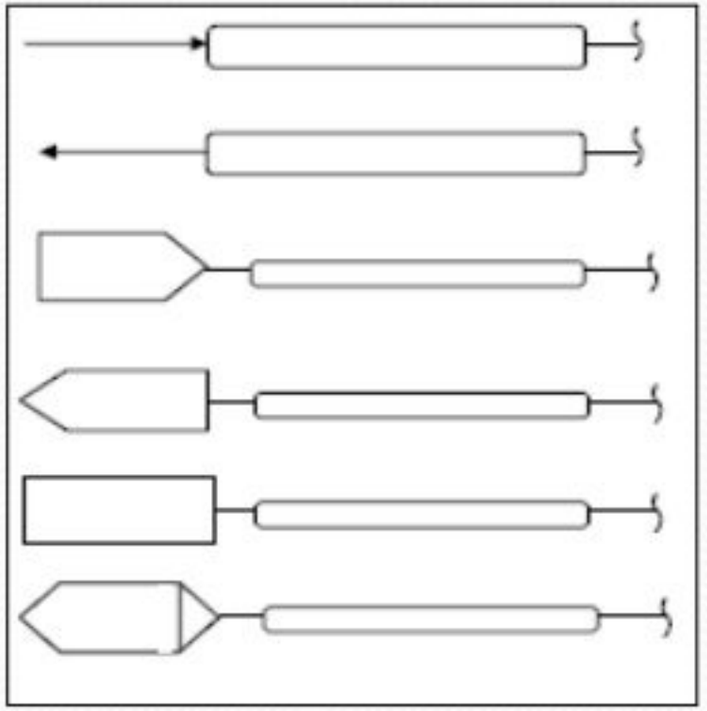


Line Continuation

- In almost all processes in chemical plant, various materials are transferred to different parts of the plant.
- In such cases, one P&ID sheet is not sufficient to show all piping systems of that material spread in various parts of plant.
- We have to continue the pipeline flow in the next sheets also

→ **Line continuation symbols**

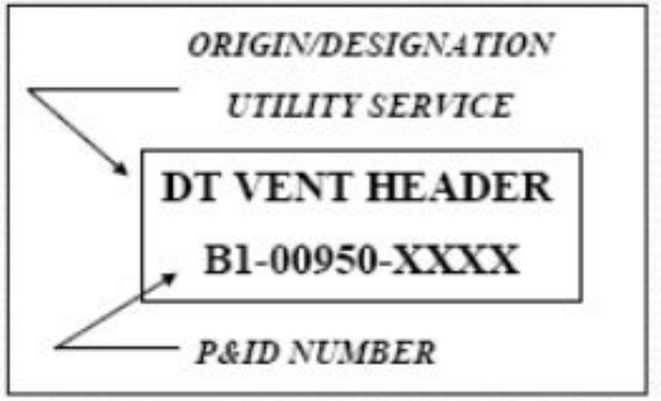
- Line continuation symbols show piping connections between different P&IDs.
- It helps to correlate the connections of some materials in different processes within the plant.



Piping Components

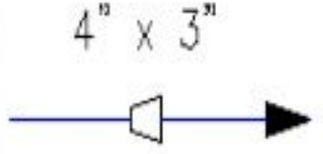
Utility Piping:

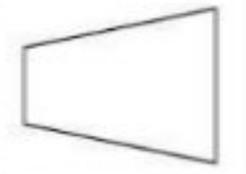
- Shown similar to the process piping in all respects
- Except continued to the margins of the process P&IDs
- Begins or terminates at a non-directional box shown on P&ID
- BOX- Name of the utility and Drawing no. of utility diagram

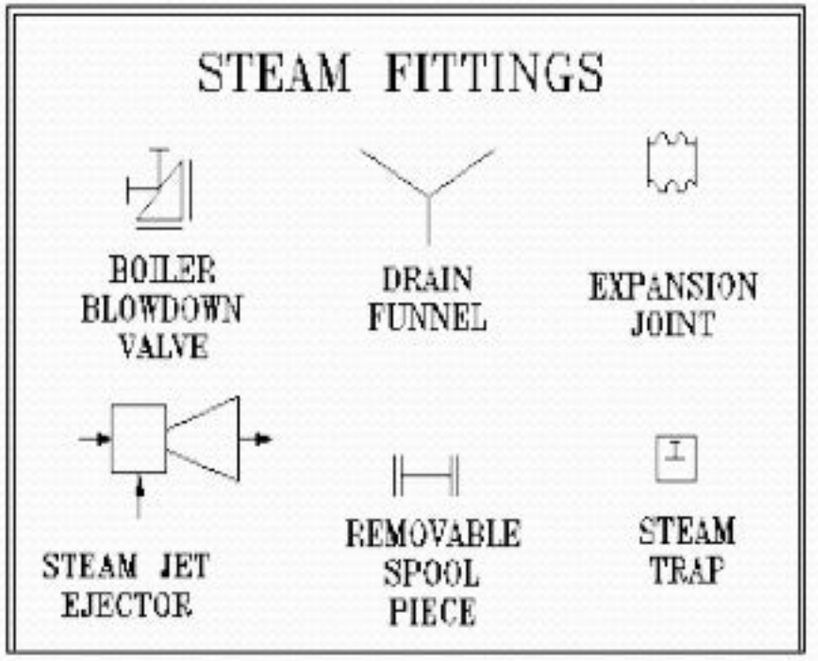


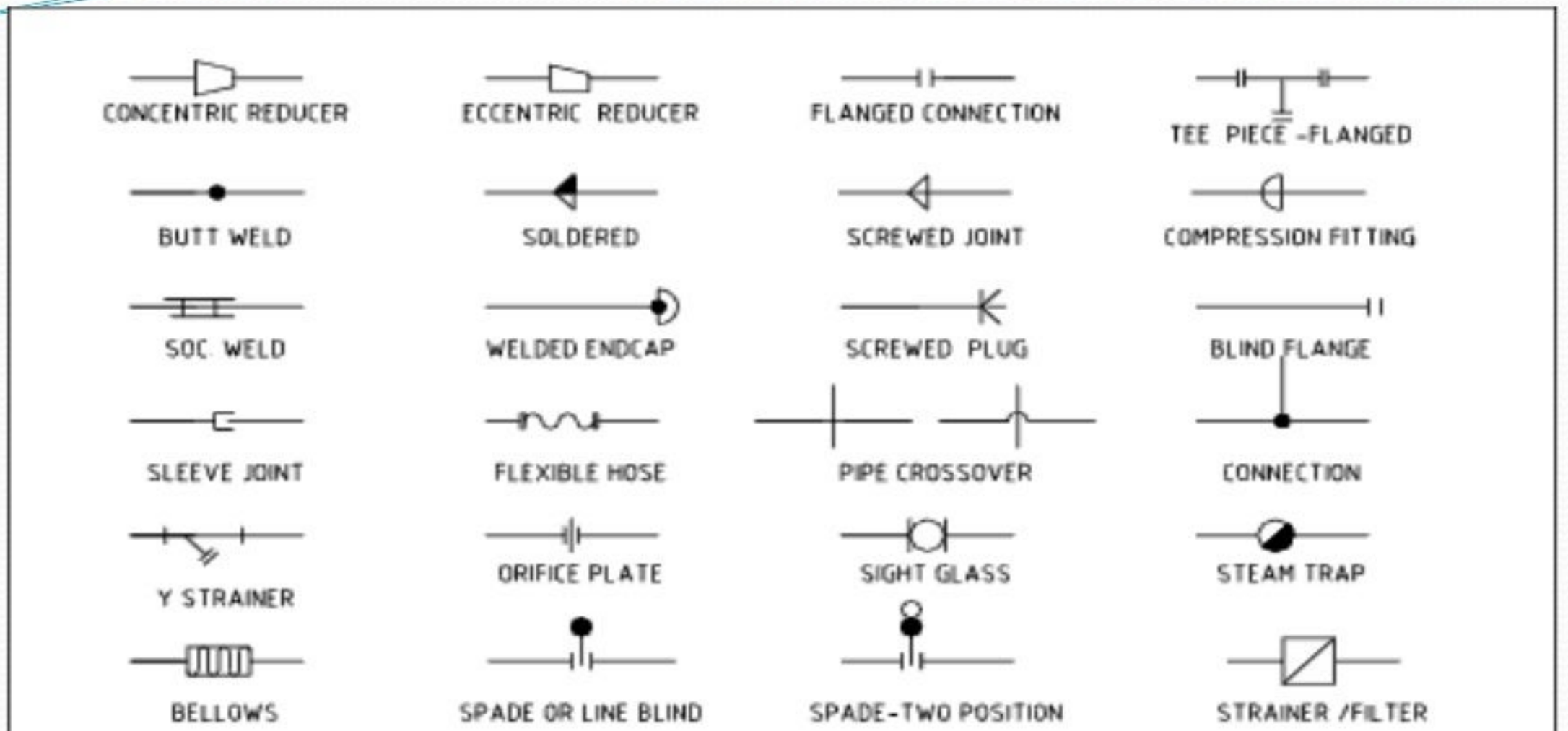
Miscellaneous Piping Items:

- All manual valves
- Self-contained regulating valve
- Rupture/Safety devices
- Drains
- Vents
- Flush connections
- Steam and Air traps
- Reducers /Expanders



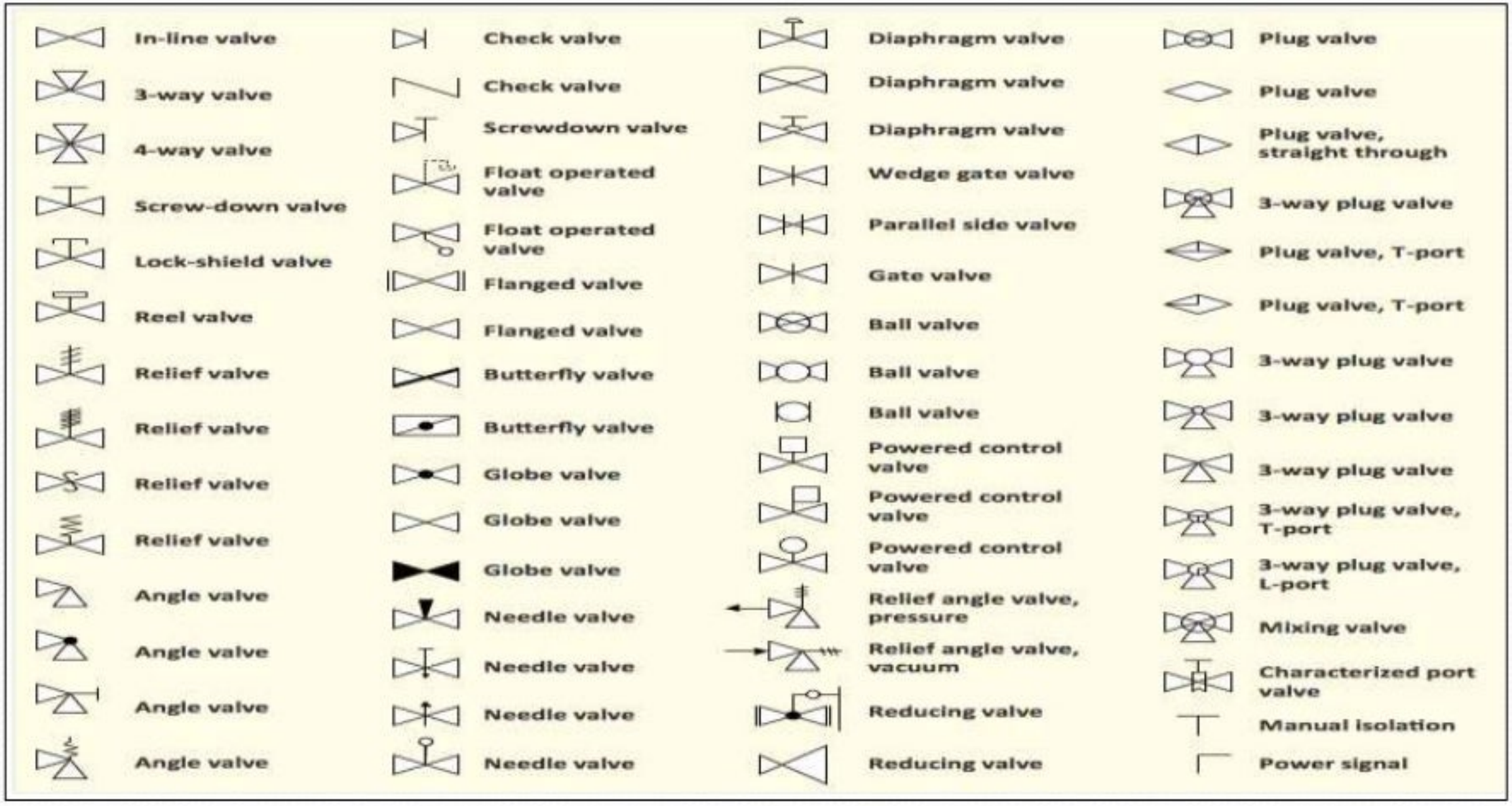






LINE FITTINGS

Valves on Piping



Instrument Symbology

- An instrument is a device that measures a physical quantity such as flow, temperature, level, distance, pressure.

- Instrumentation is the use of measuring instruments to monitor and control process.

- As a chemical plant has different processes occurring and we use instruments for the following reasons:
  - Reduce Variability
  - Increase Efficiency
  - Ensure Safety

- P&IDs shows all instruments present over the plant in various processes.

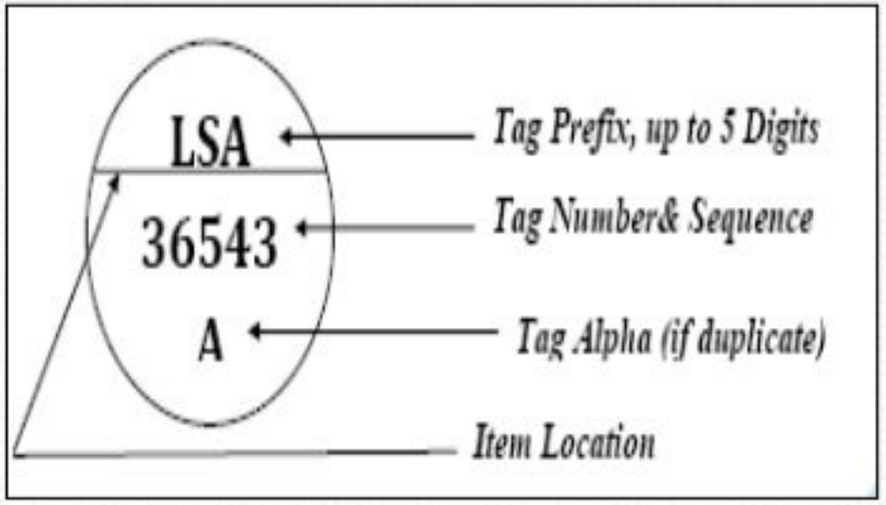
- Every instrument is identified and shown both schematically and symbolically on the P&IDs.

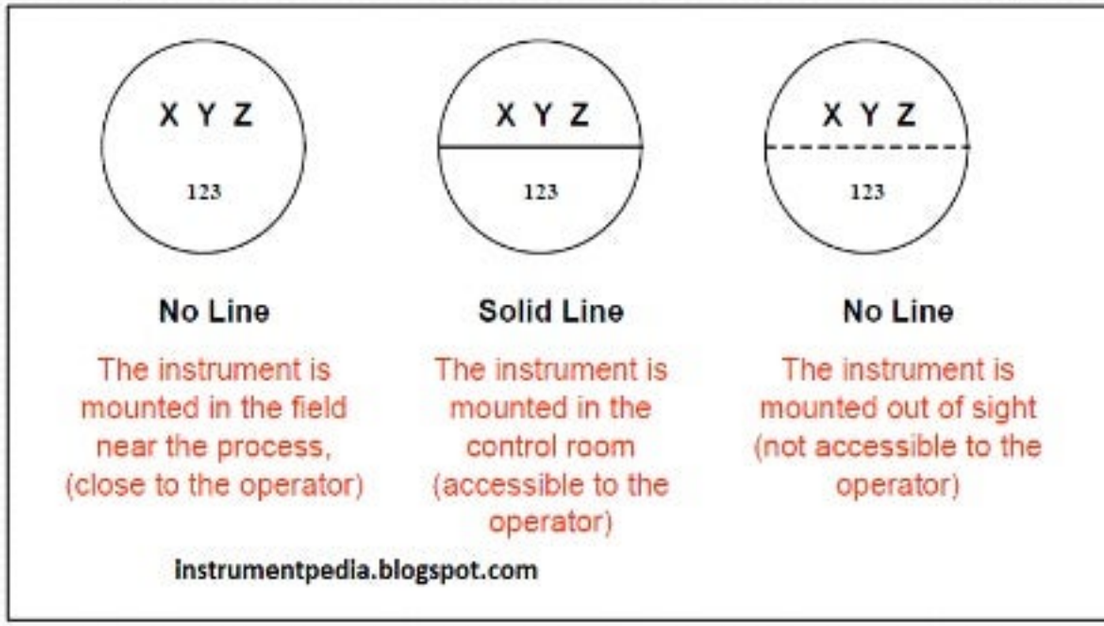
- Instrument specifications give the particular type, service, range, and manufacturer.

Instrument Identification

1. **Tag Prefixes**: 1st Letter, 2nd Letter & 3rd Letter
2. **Tag Number**: P&ID number and Sequence
3. **Tag Alphabetic**: In case of Duplicate
4. **Item Location**:

- No Line → On Field
- Solid Line → In control Room Panel
- Dash Line → In control Room Behind panel
- Double Solid Line → On Remote Panel
- Double Dash Line → Behind Remote Panel

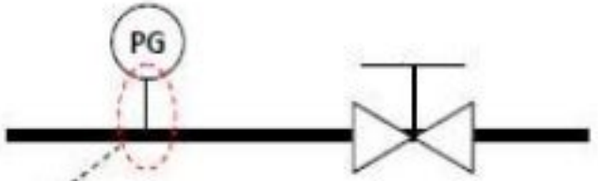




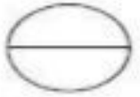
Process piping and sub-piping

A thick straight line represent main process piping

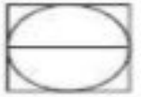
A thin straight line represent process sub-piping either to instruments or by-pass process line.



A circle representing locally mounted instrument



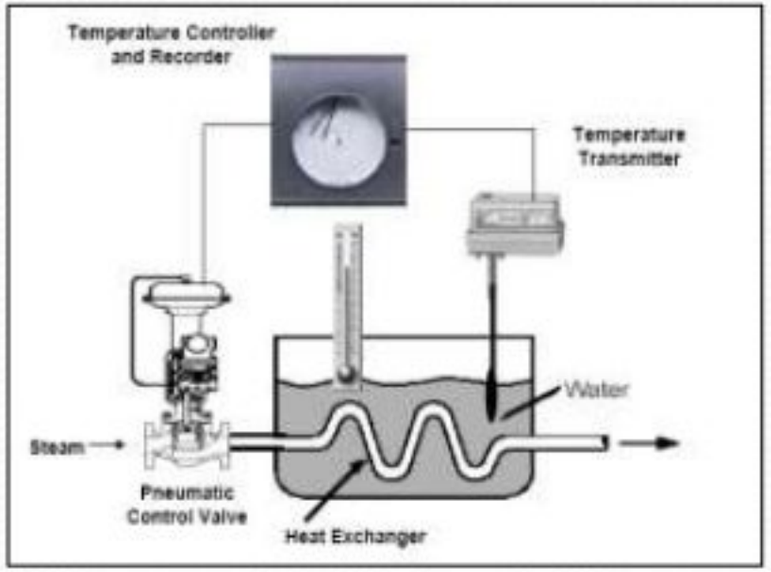
A circle with horizontal line representing control room panel mounted instrument.

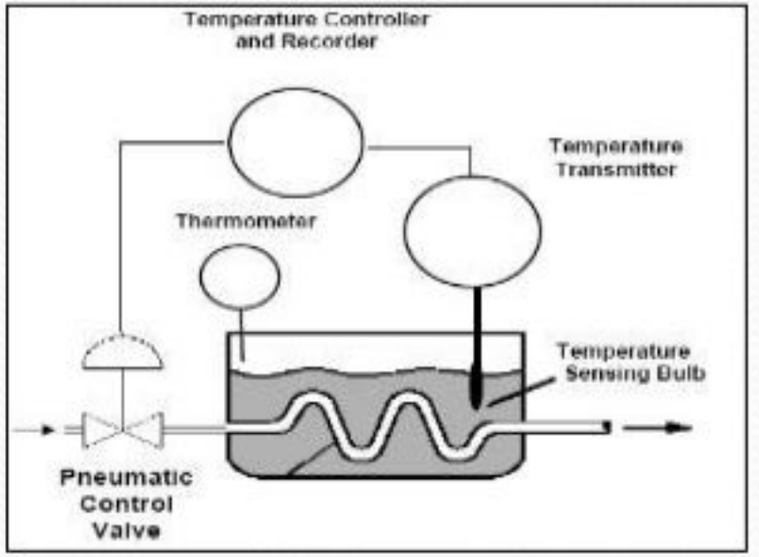


A circle with horizontal line inside a square representing its function in DCS.

Industry to P&ID

1





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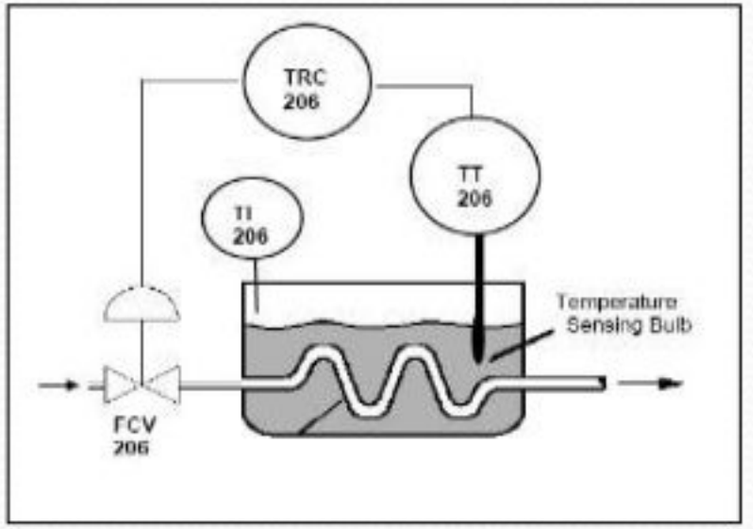

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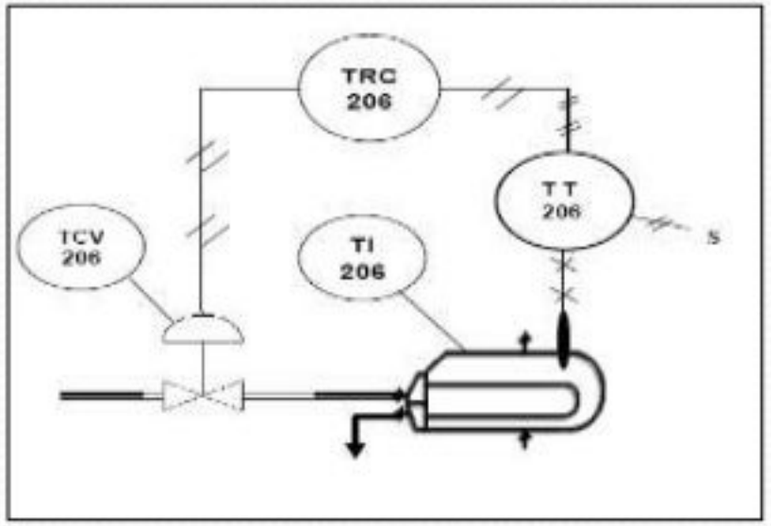
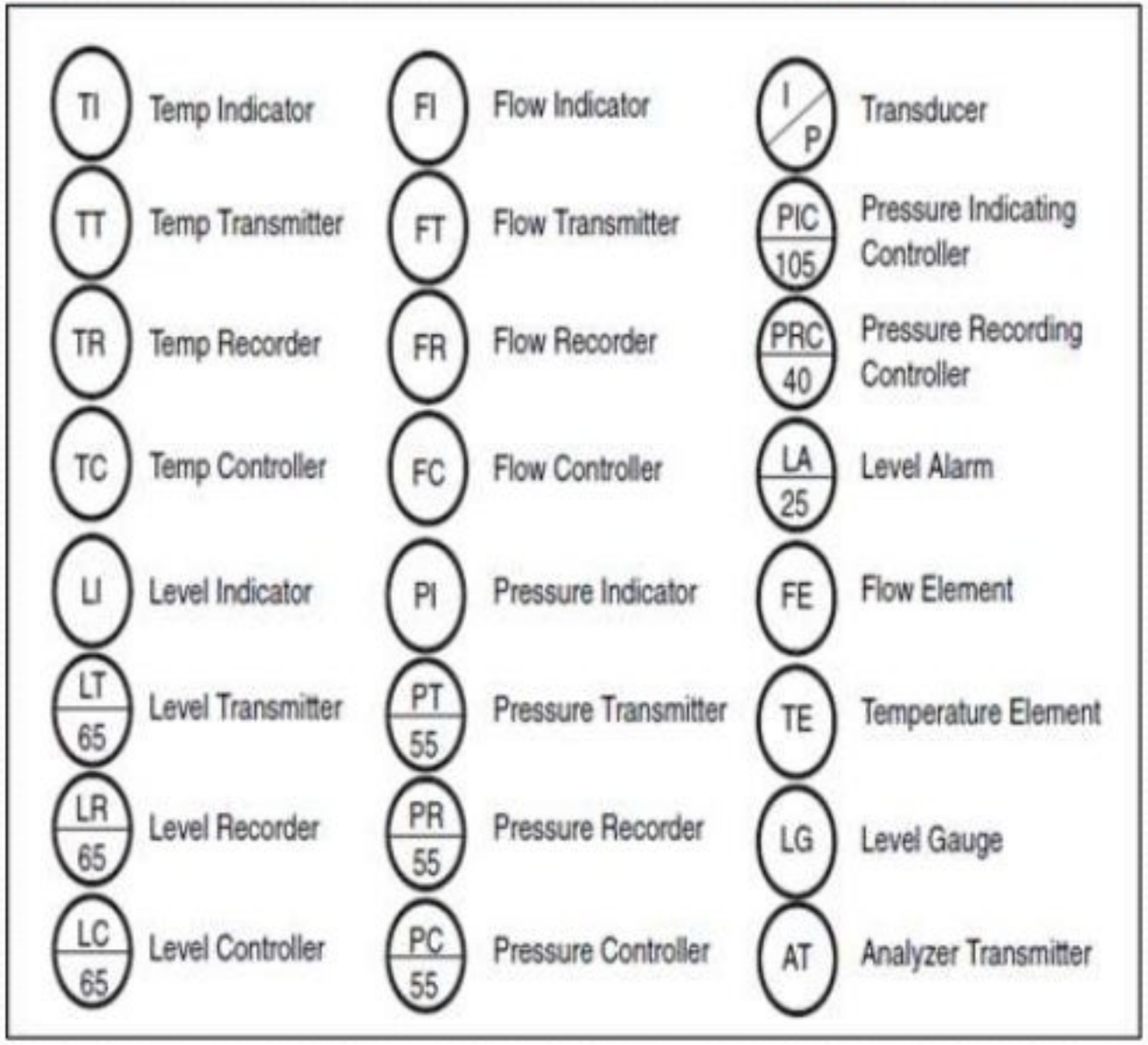
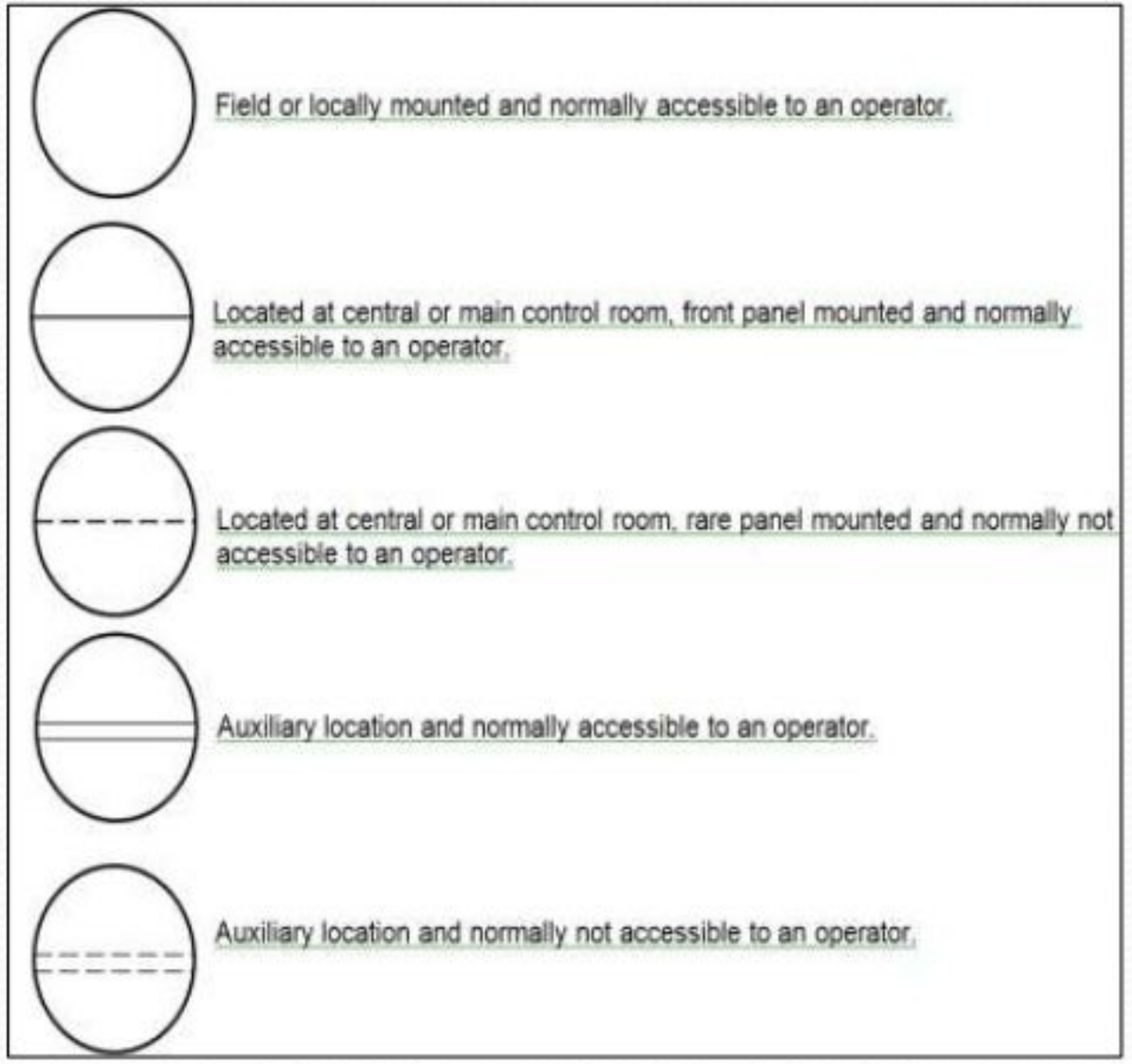


Tag Symbols



Tag Prefixes

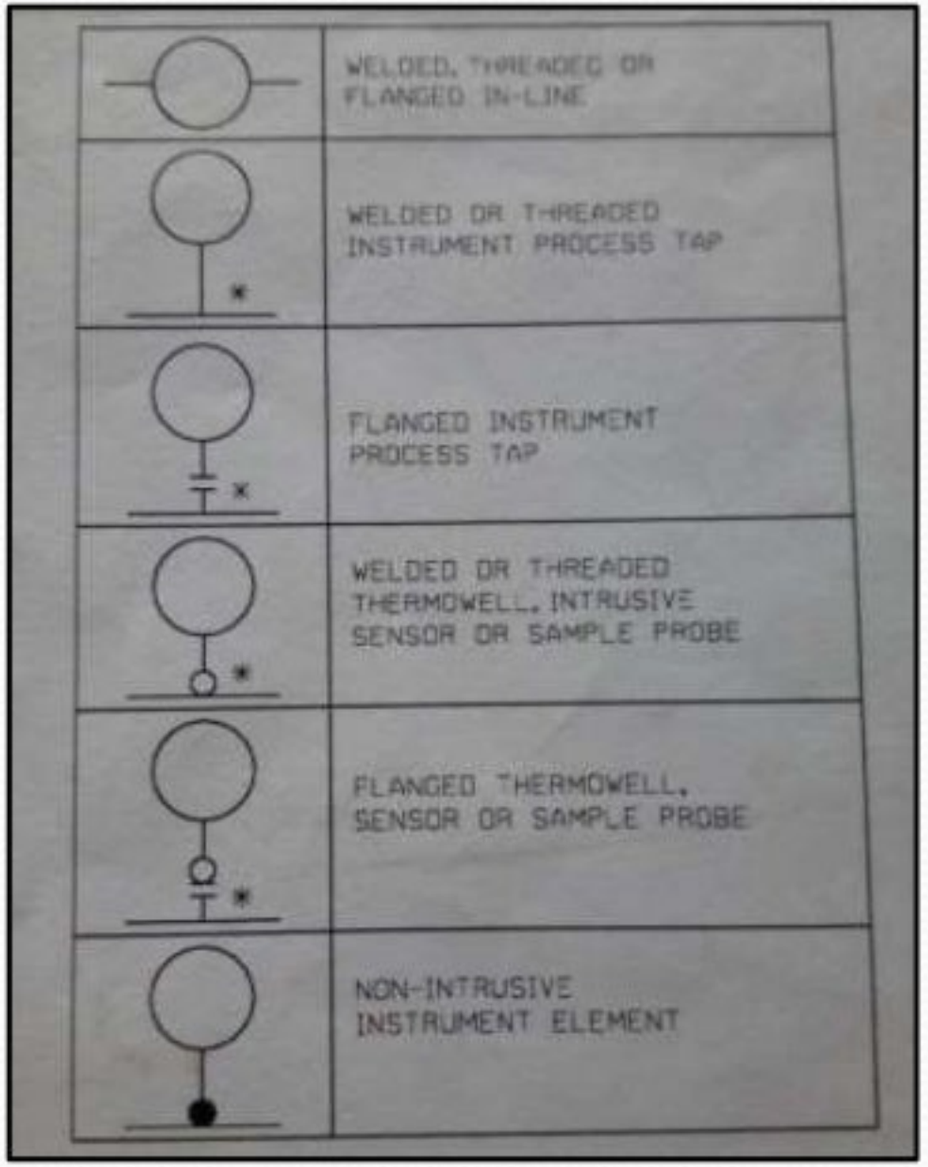


Item Location

Instrument Connections

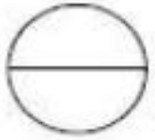
- Welded, threaded or flanged in-line
- Welded or threaded instrument process tap
- Flanged instrument process tap
- Welded or threaded thermo well sensor or sample probe
- Flanged thermo well sensor or sample probe
- Non-intrusive instrument element

e.g. Temperature, Pressure, Level Instruments



Instrument Control System

A circle representing locally mounted instrument



A circle with horizontal line representing control room panel mounted instrument.

A circle with horizontal line inside a square representing its function in DCS.

Instrument Control System

- **Instruments** – To measure and record all process parameters

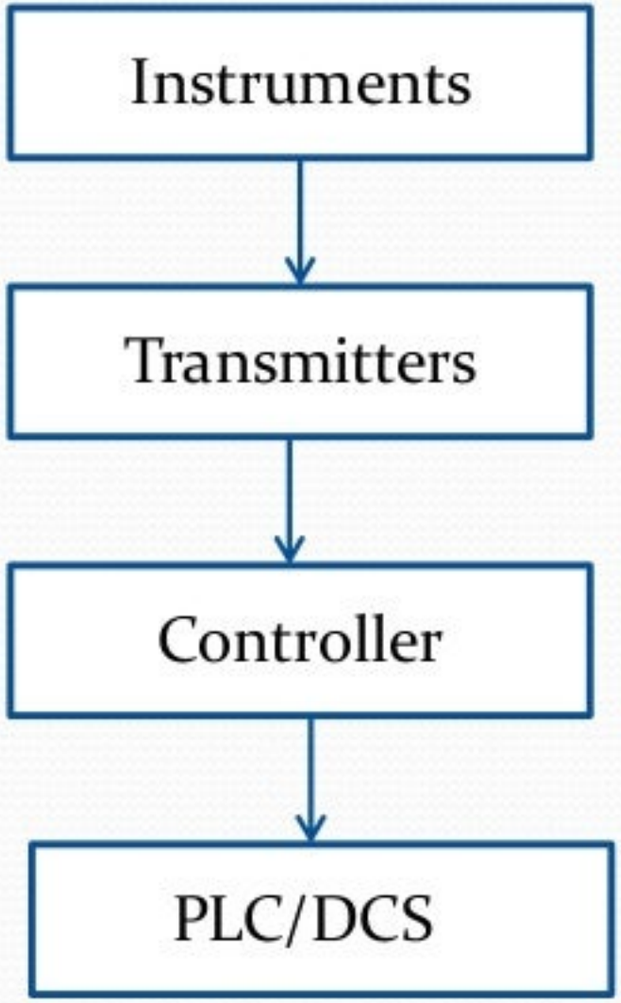
- **Transmitters**- To produce an output signal often in the form of electrical current signal

- **Computerized controller** – To monitor and control the parameters at PLC/DCS

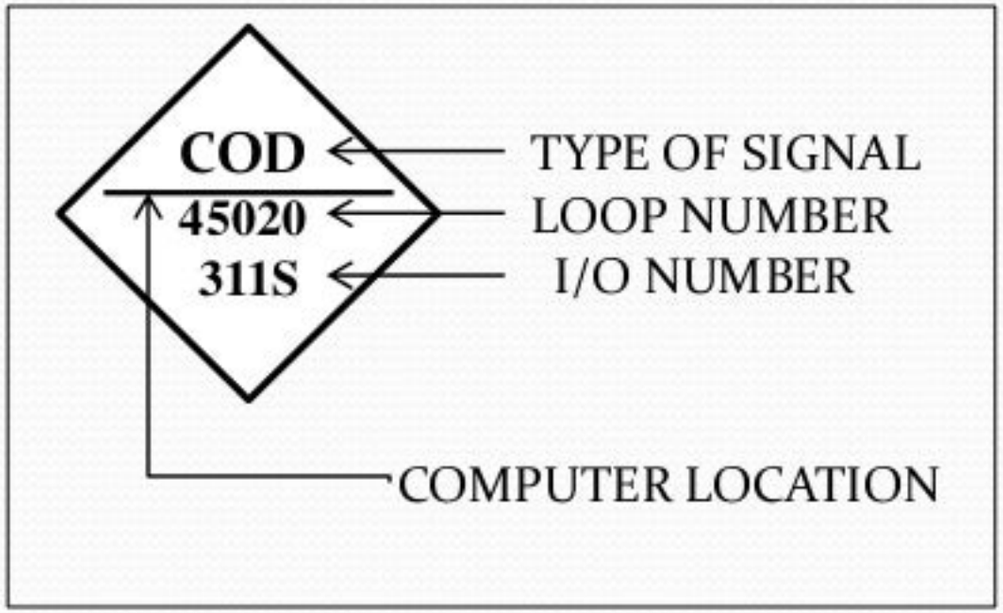
- **PLC/DCS** – To interpret it to readable values and used to control other devices and processes

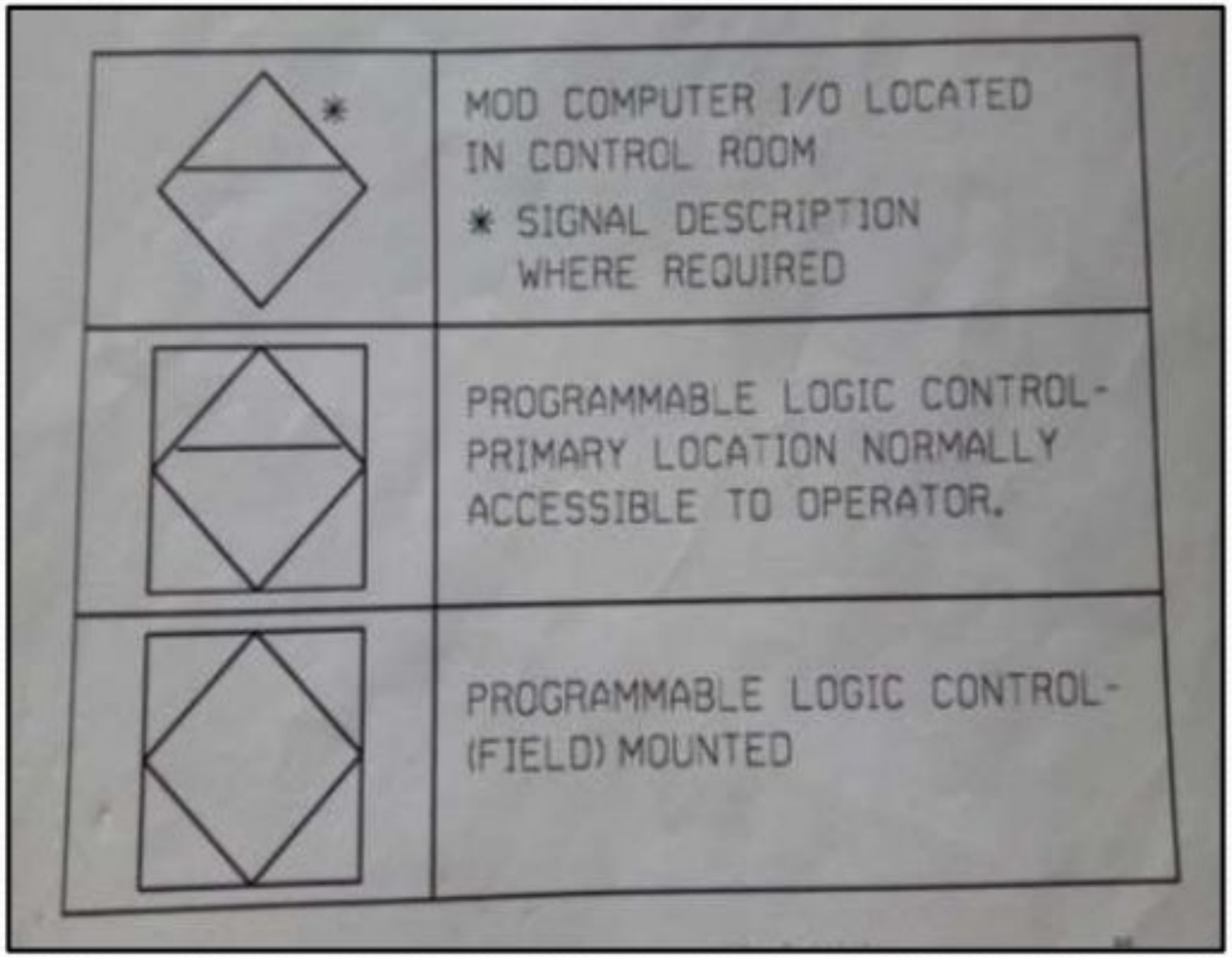
- Computer devices play a significant role in both gathering the information from the field and changing the field parameters
  -KEY PARTS OF CONTROL LOOP

- These devices are shown by some " CPU I/O Symbols ".



CPU I/O Symbols

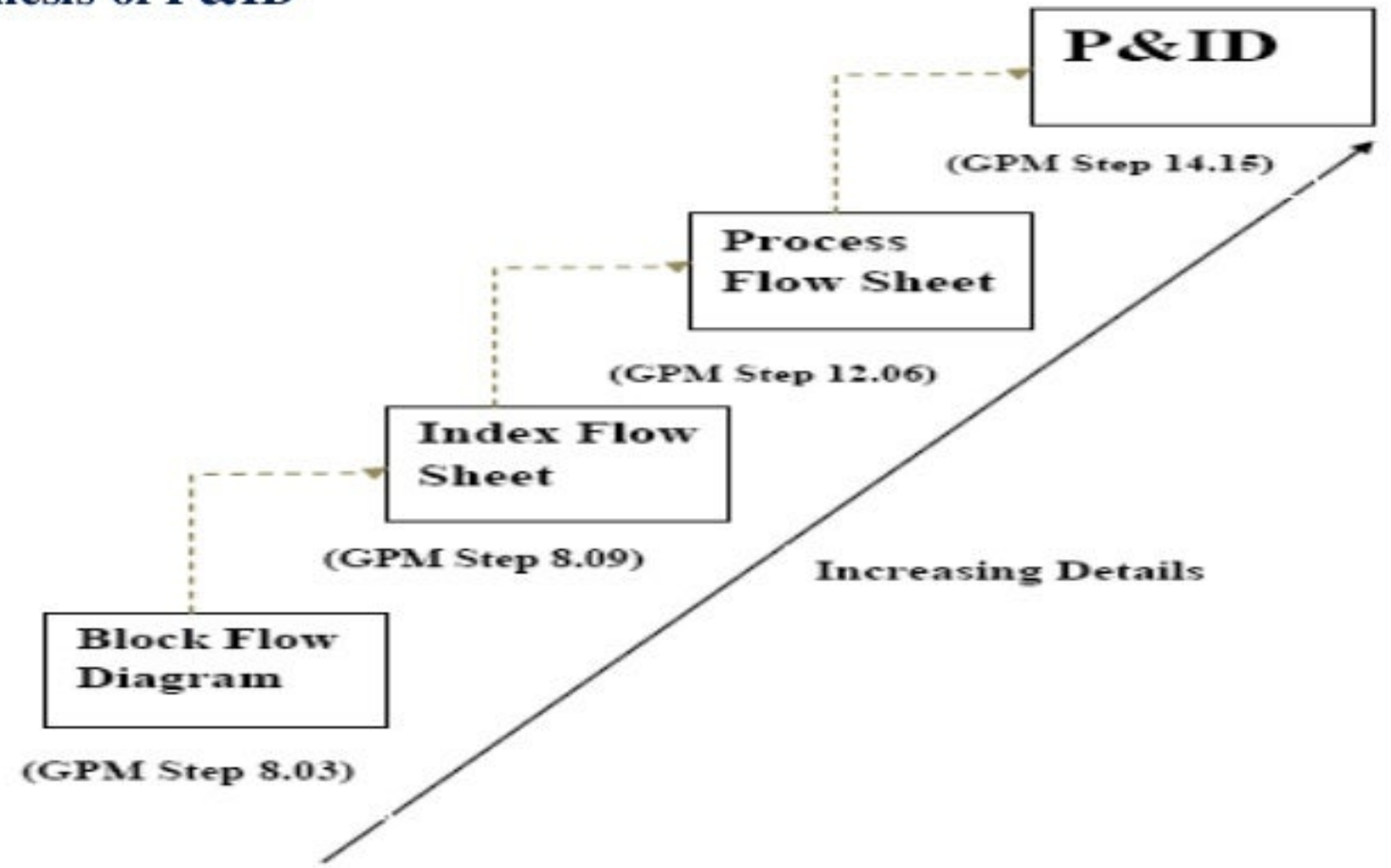




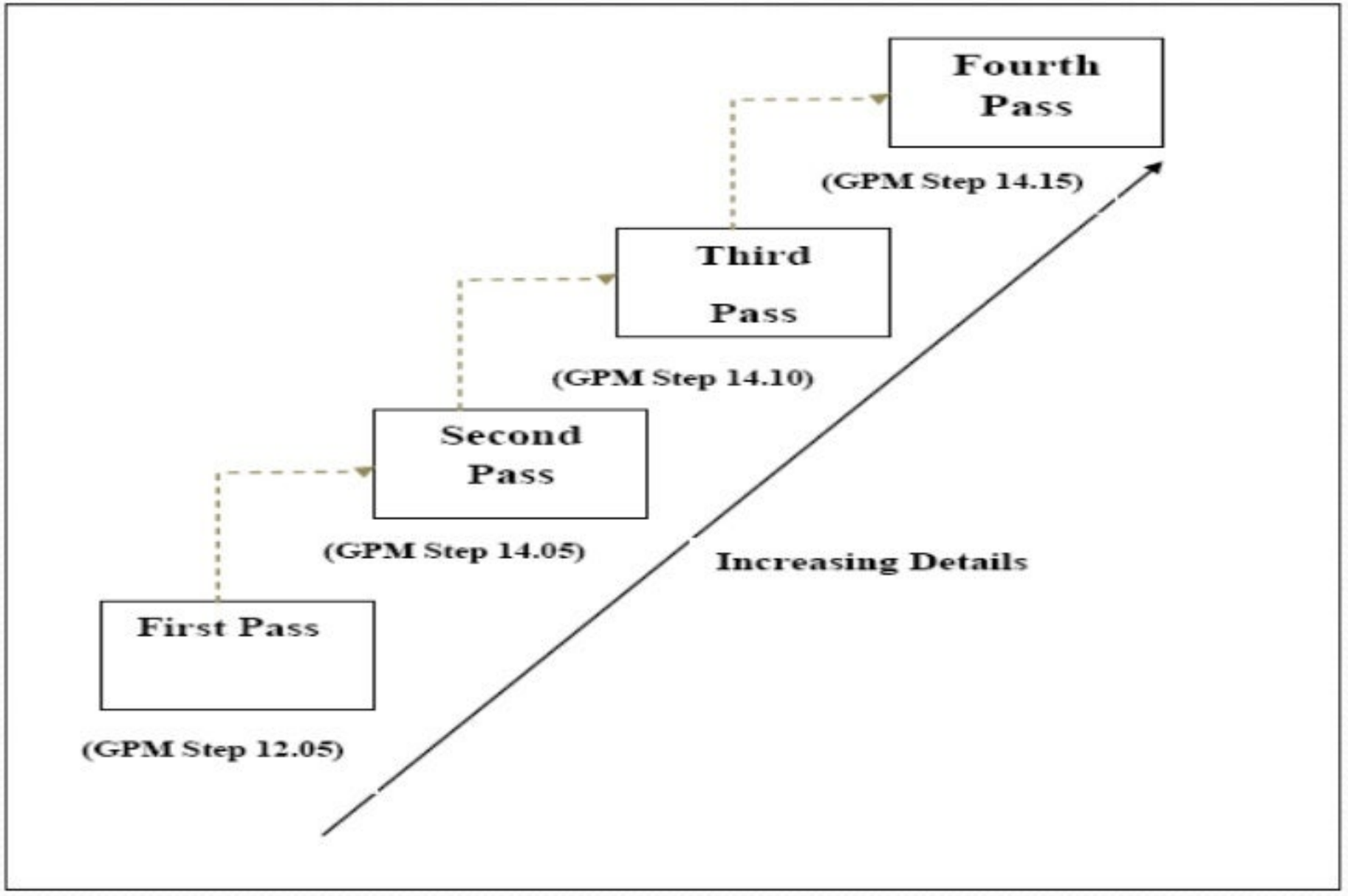
P&ID Creation

(Global Project Methodology)

1. Genesis of P&ID



2. Stage Developments of P&ID



Industrial Applications

The detailed design approach requires various departments to supply a great deal of data with other. Listed are various fields that use P&IDs :

- Process Engineers
- Piping/Mechanical Engineers
- Electrical Engineers
- Instrumentation Engineers
- Structural/Civil Engineers

Software and Sources

- AutoCAD P&ID
- AVEVA P&ID
- EPLANT
- SmartPlant
- Lucid Chart
- DesSoft
- Microsoft Visio
- Engineering Toolbox- Online Drawing

Conclusion

Any **Queries** ??

Thank You...!