Use and Importance of Piping and Instrumentation Diagrams (P&IDs)

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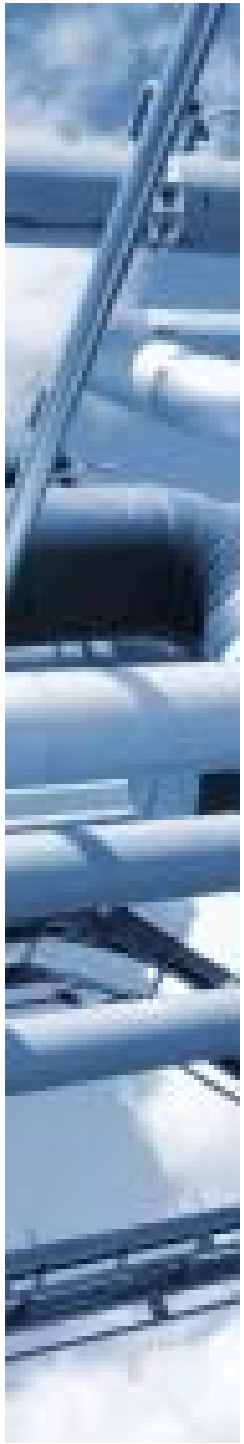
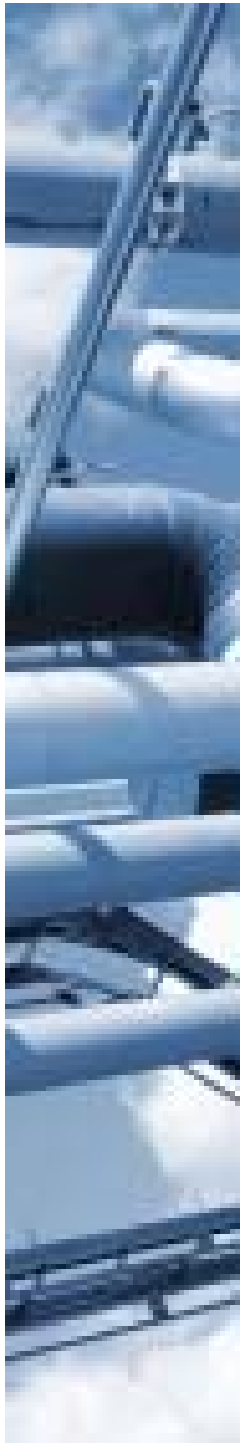
TOPICS

- Use of P&IDs
- Key Elements
- Importance of Quality P&ID's During a HAZOP Study
- Signs that a P&ID has not been Field-Verified

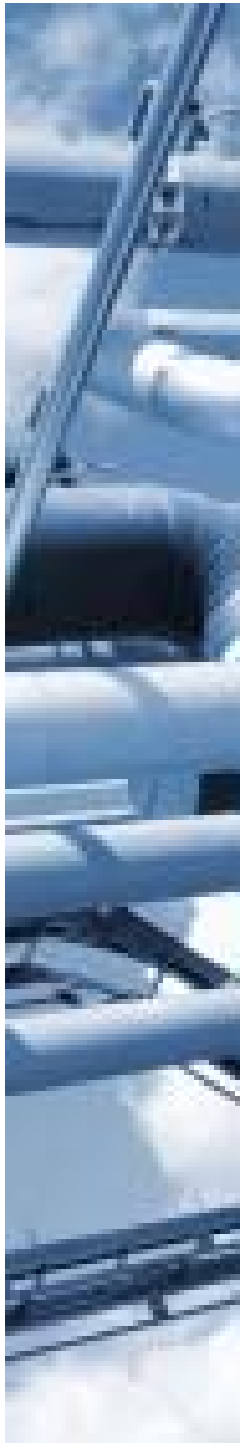


Use of P&IDs



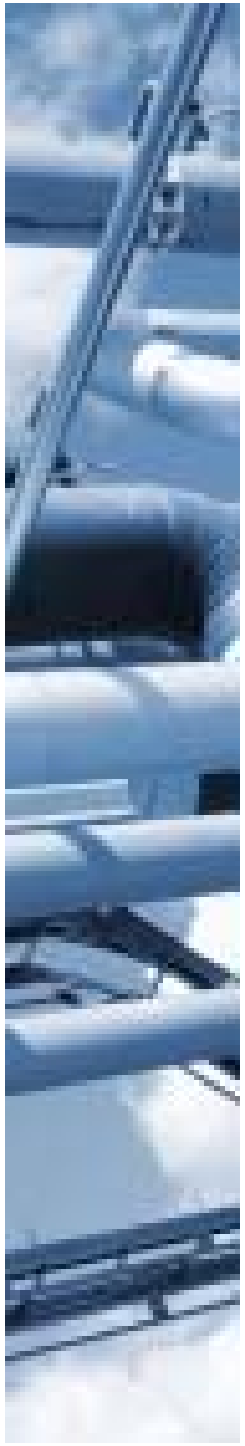
Purpose of a P&ID

- It is a representation of a process or system and how it functions.
  - Depicts the sequence between components within the process.
  - Provides information on instrumentation and equipment interface
  - P&IDs are *not* a physical or mapping representation of the system (Two items side by side on a P&ID can actually be in different buildings or on opposing sides of the process plant.)
- A picture paints a thousand words



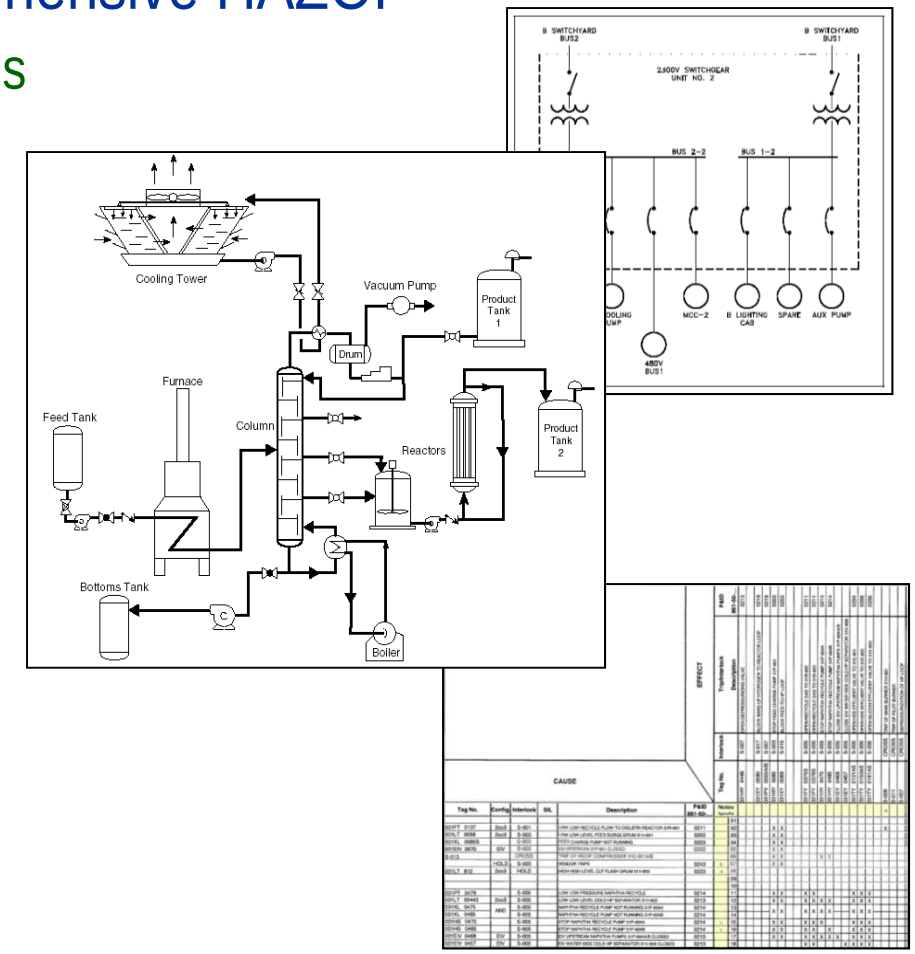
Utilizing P&ID's

- P&IDs are a useful tool during a HAZOP
  - Enable the Team to understand the process
  - Allow for systematic evaluation based on representative P&ID flows (Node development)
    - Enables to keep the Team focused and aligned
  - Valve/equipment identification (tag) numbers in P&ID synched with HAZOP report documentation
    - Facilitates identification of safeguards
  - Process design and conditions defined in P&IDs used to evaluate the process during the HAZOP

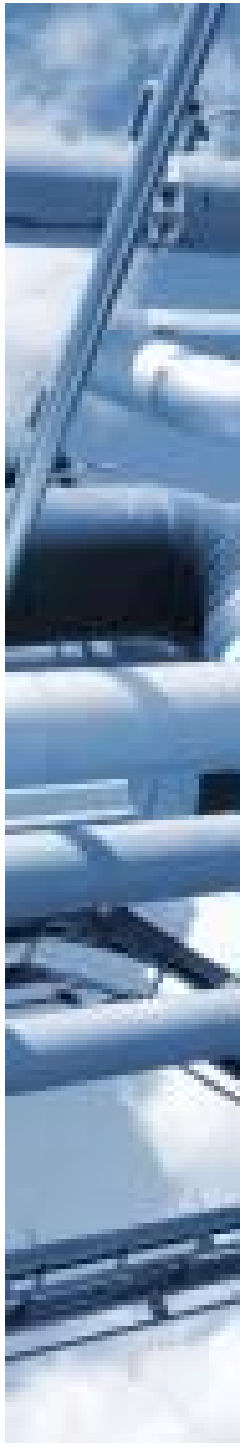


Utilizing P&ID's (cont)

- Can be used alongside other useful maps and diagrams for a comprehensive HAZOP
  - Process Flow Diagrams
  - Cause and Effect Diagrams
  - Electrical Diagrams
  - Site Maps
  - Chemical Detection/ Monitoring Maps

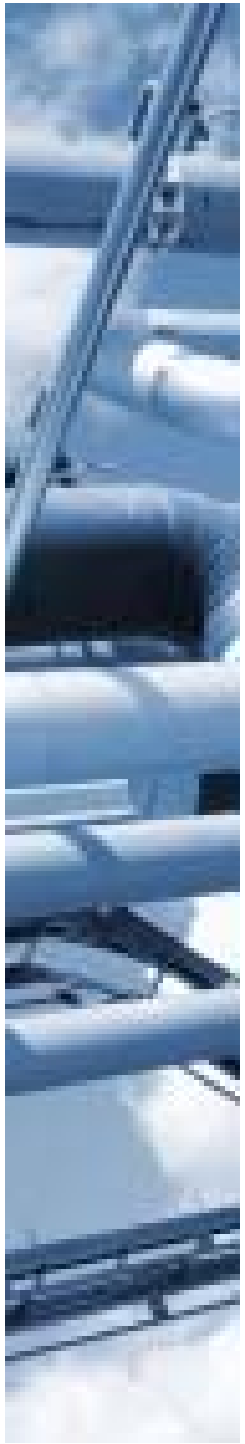


Key Elements

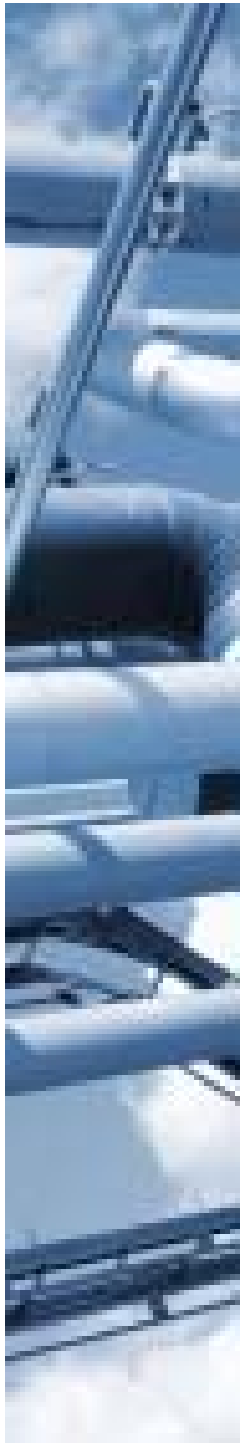


Summary of Key Elements

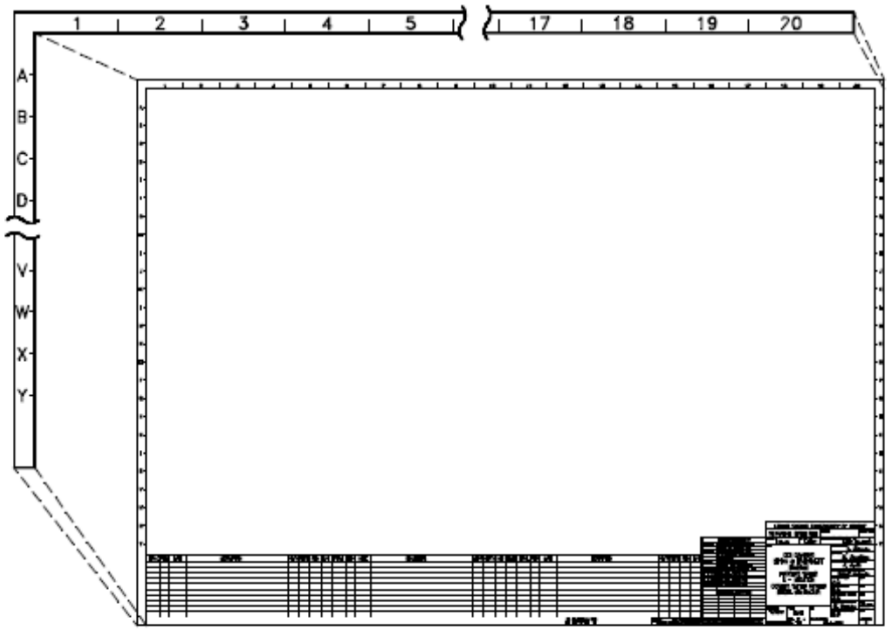
- General P&ID layout
- Legend
- Piping
- Valves
- Instrumentation
- Equipment



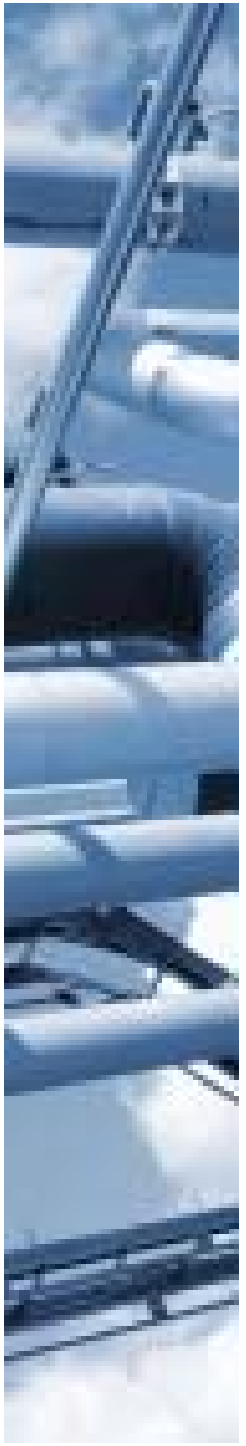
P&ID Layout



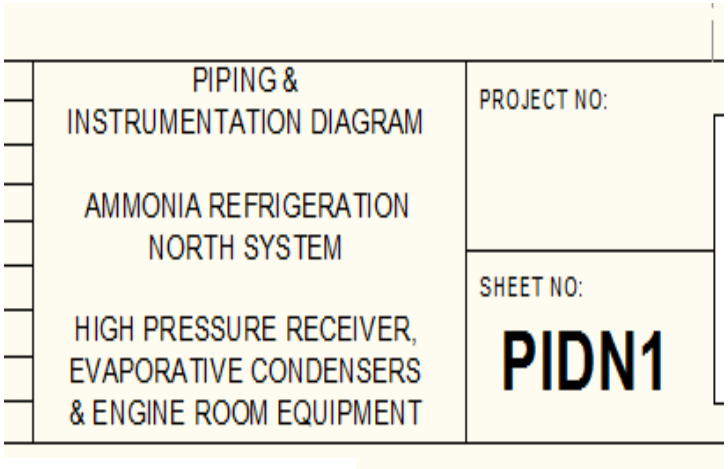
Grid



- Grid enables reader to easily locate equipment, valving, etc, for complex P&IDs.



Information Blocks



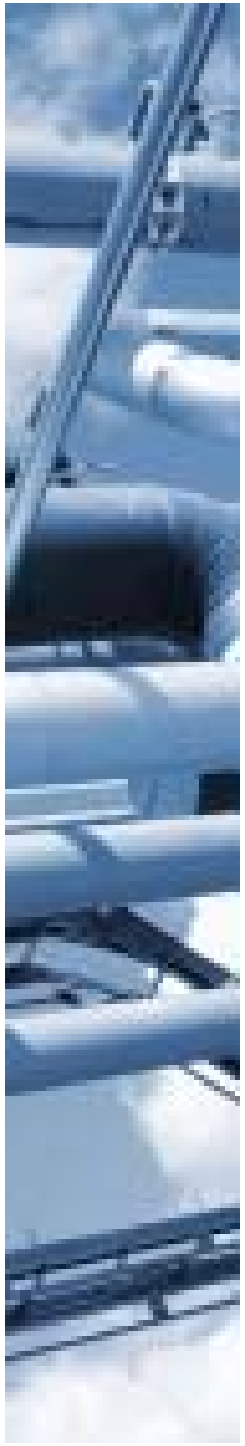
TITLE BLOCK

- Title block enables identification of system and drawing numbers
- Revision block provides information on history of changes to process.

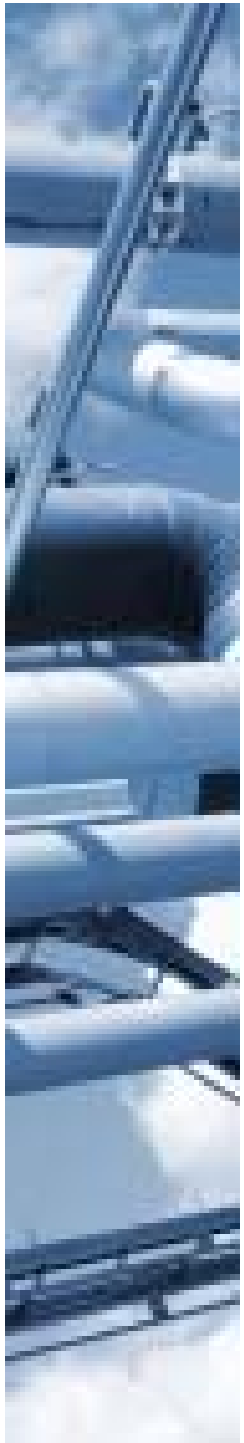
REVISION BLOCK

REVISIONS

REVISION NO.	DATE	DRAWN BY	APPROVED BY	DESCRIPTION
0	MAR 2008	RMP – SMM		Original Design and Installation

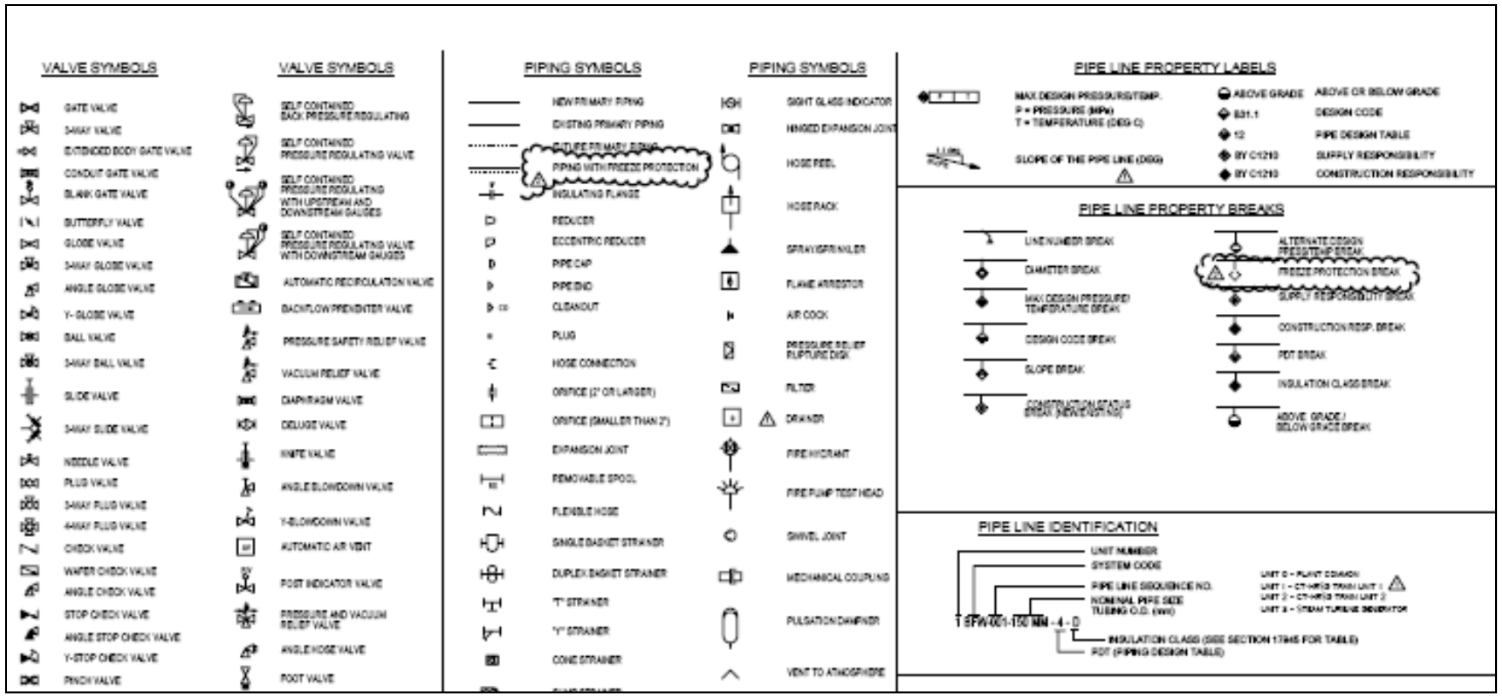


P&ID Legend

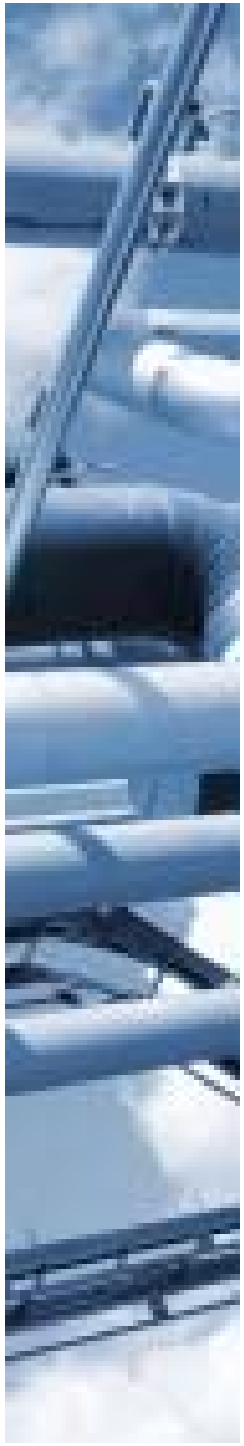


Legends

- A legend is useful to understand the P&ID
  - –Defines symbols with corresponding piping type, equipment type, valve type, etc.
  - –Provides alignment of individuals participating in the HAZOP



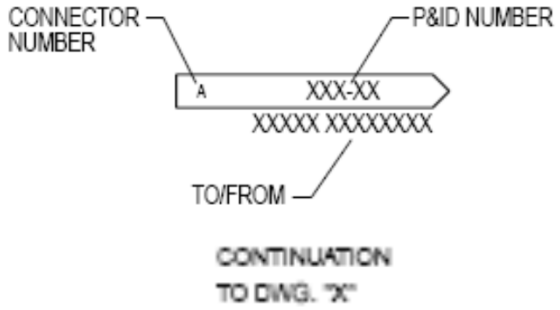
Piping

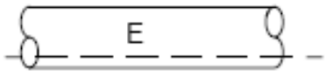


Piping - Common Line Symbols

EXIST. PIPING
TO BE DEMOLISHED

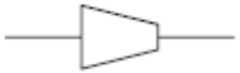
EXIST. PROCESS
PIPING





HEAT TRACING
E-ELECTRIC
S-STEAM

INSTRUMENTATION
TIE-IN

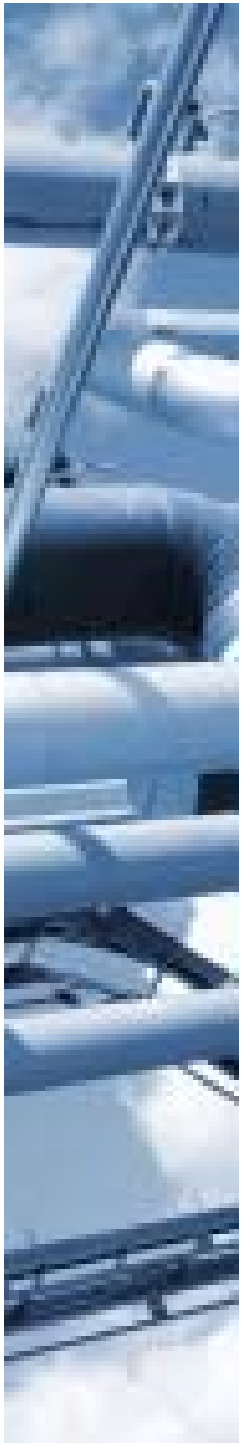


CONCENTRIC
REDUCER

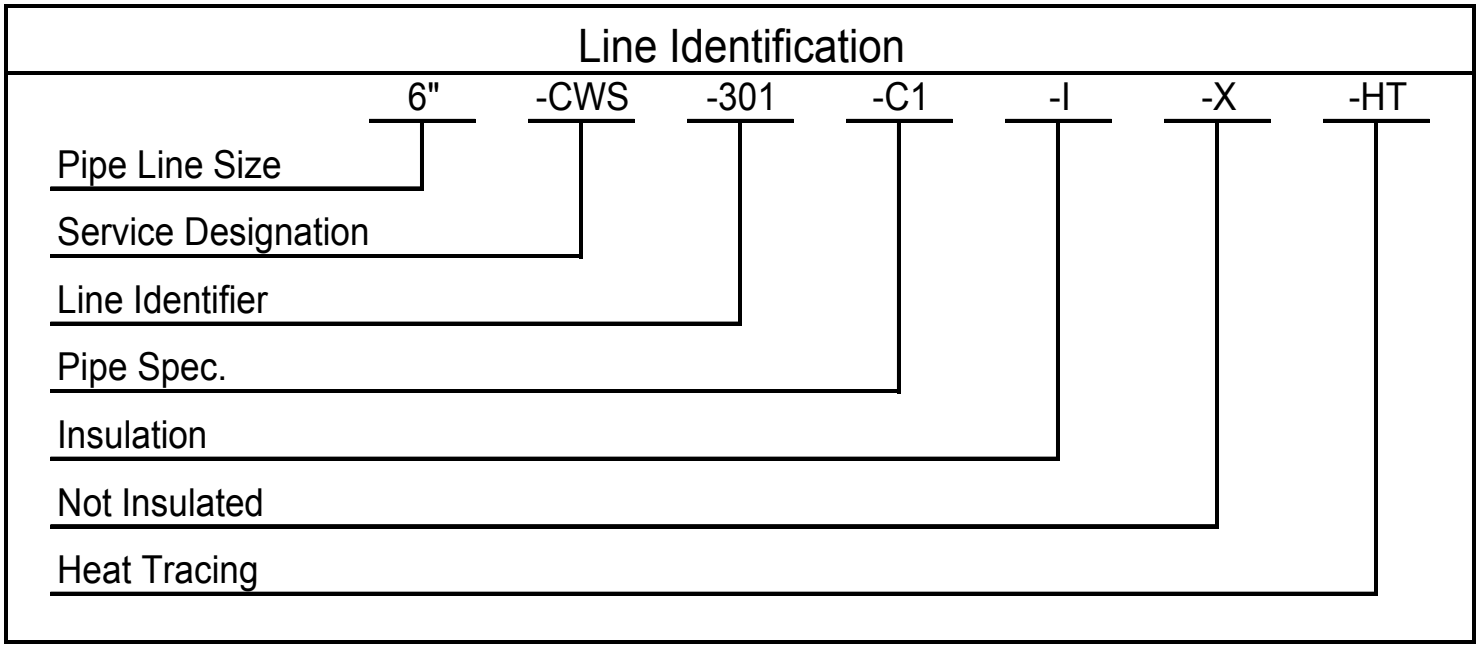
PNEUMATIC
LINE

FILLED
CAPILLARY

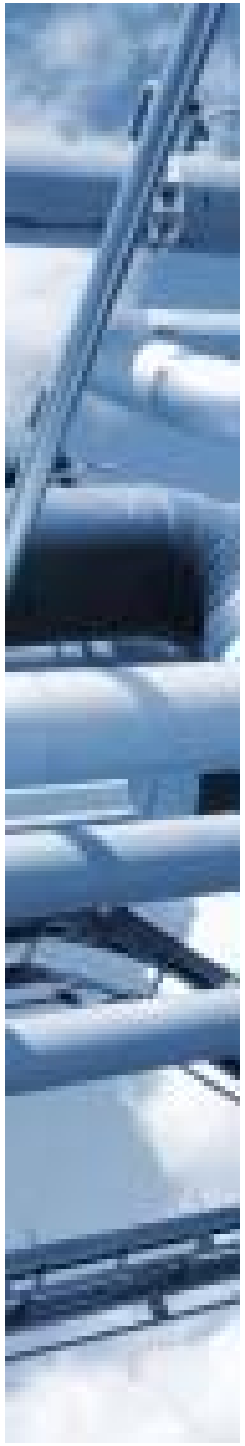
ELECTRIC
SIGNAL



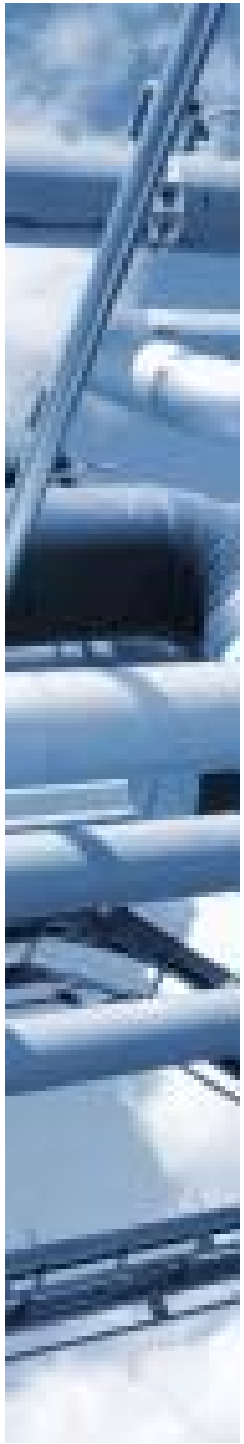
Line Identification



Provides detailed information of the process flow piping design and specifications.



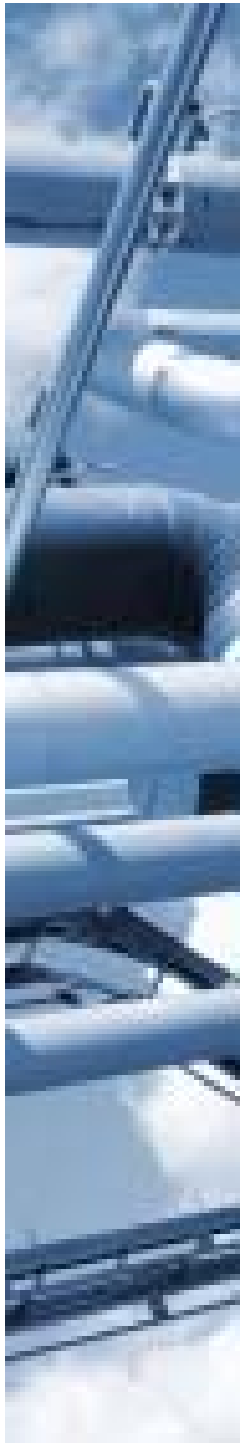
Valves



Valve Symbology

Different types of internal mechanical configurations include:

Type:	Sample Symbol:
– Gate Valve	
– Globe Valve	
– Ball Valve	
– Butterfly	
– Needle	

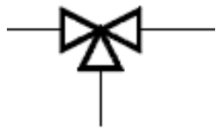


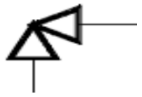
Other common valves

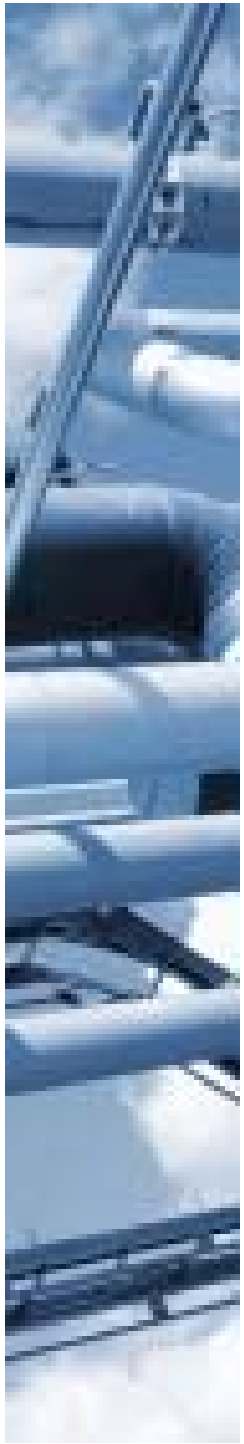
Type:

- Multiport Valve
- Angle Valve
- Check Valve
- Pressure Relief Valve

Sample Symbol:





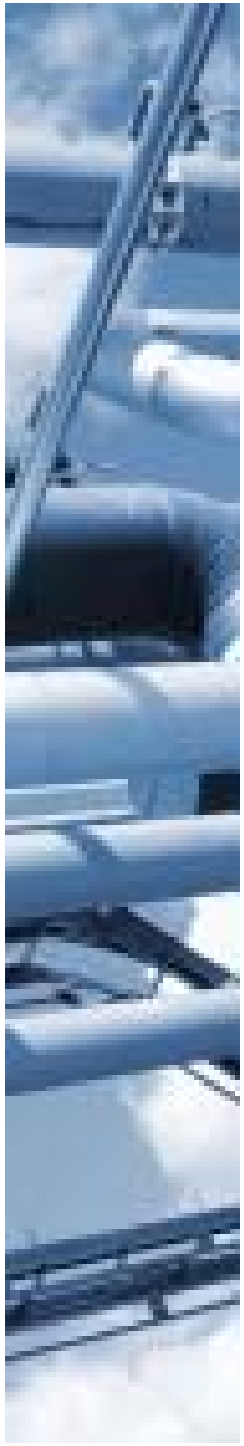


Valve Conditions

Positions:

Normally Closed Valve	NC
Normally Open Valve	NO
Locked Open Valve	LO
Locked Closed Valve	LC

NC



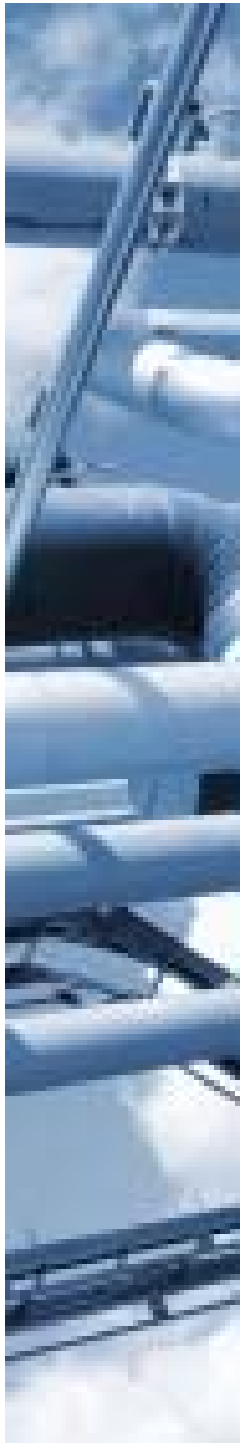
Variance In Valve Designations

Closed Valve

Normally
Closed Valve

Globe Valve

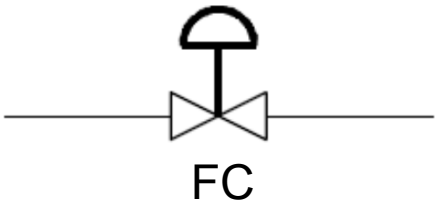
Globe Valve

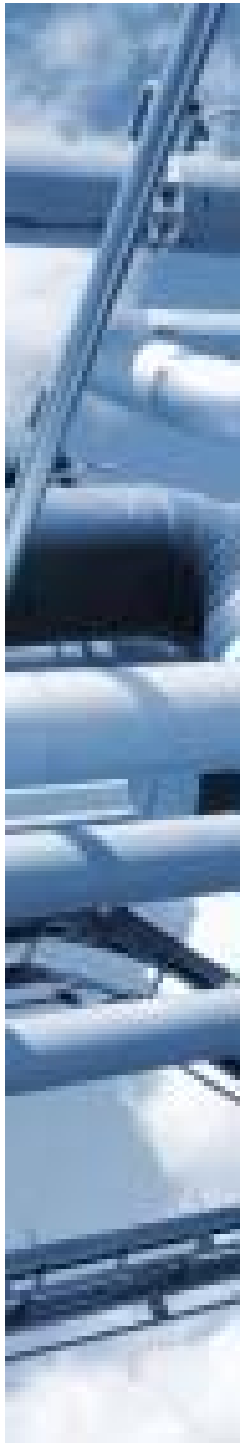


Valve Failure Modes

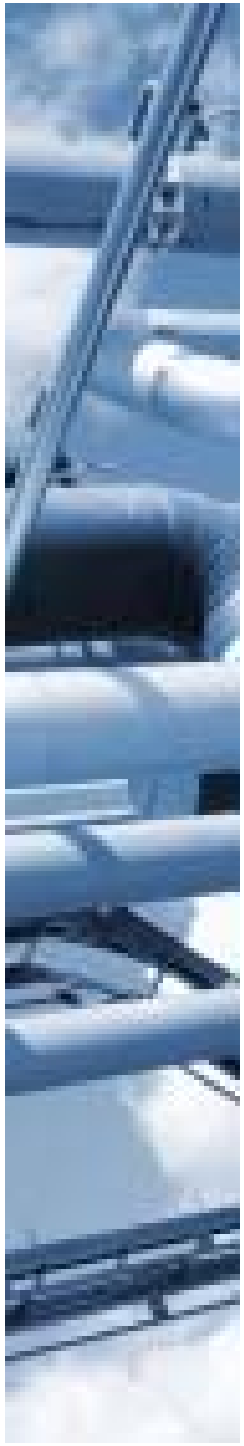
Fail Position:

Fail Closed	FC
Fail Open	FO
Fail Last	FL
Fail In Place	FI



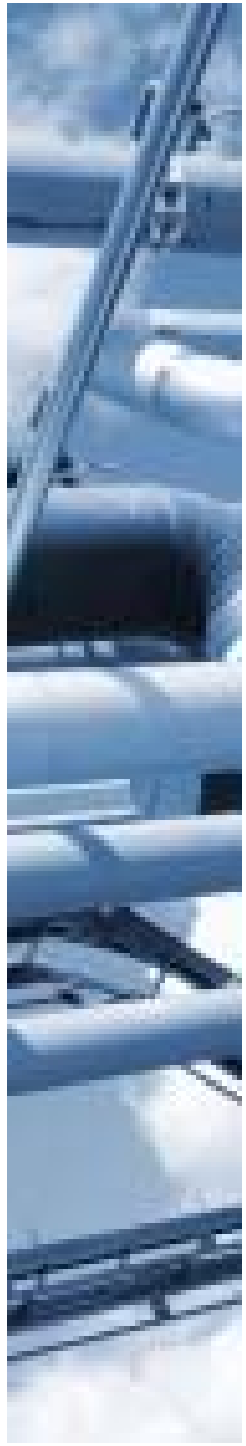


Instrumentation



Instrument Loops

- Process plants consist of instrument loops (control valve assemblies) which are designed to maintain a process variable (pressure, flow, level, temperature) within an defined operating range.
- Instrument Loop Components
  - Sensor
  - Transmitter
  - Controller
  - Actuator
- Additional Instrumentation
  - Gauges
  - Indicators and Recorders

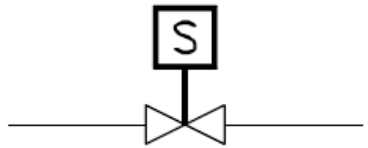


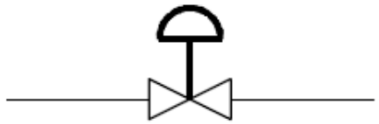
Valve Actuator Types

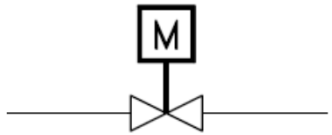
Type:

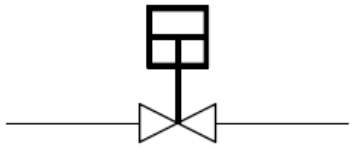
- Solenoid
- Diaphragm
- Motor
- Piston

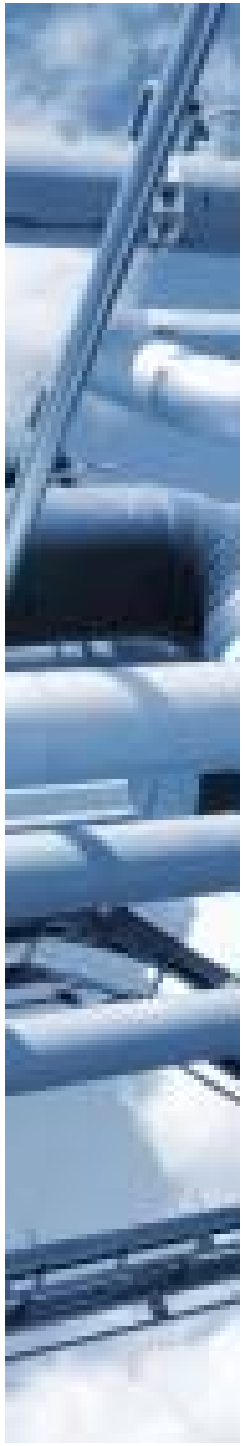
Sample Symbol:





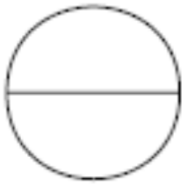




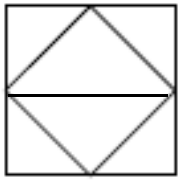


Instrument, Logic & Computer Symbols

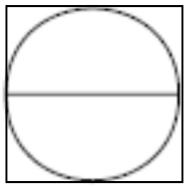
Discrete Instrument

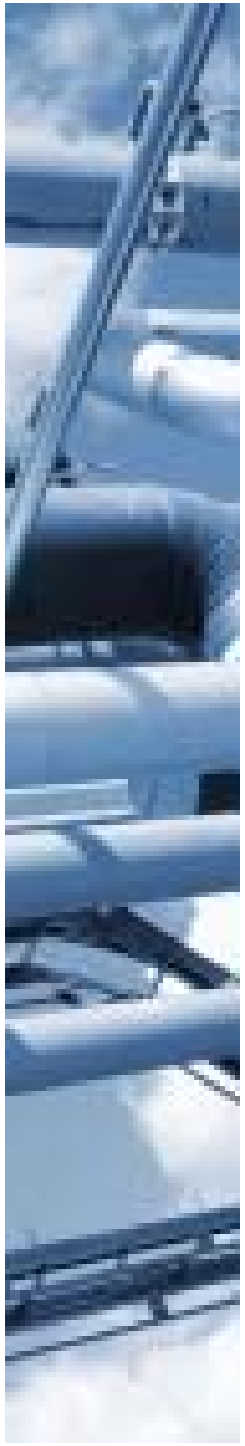


DCS: Distributed Control System

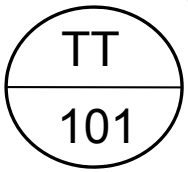


PLC: Programmable Logic Control





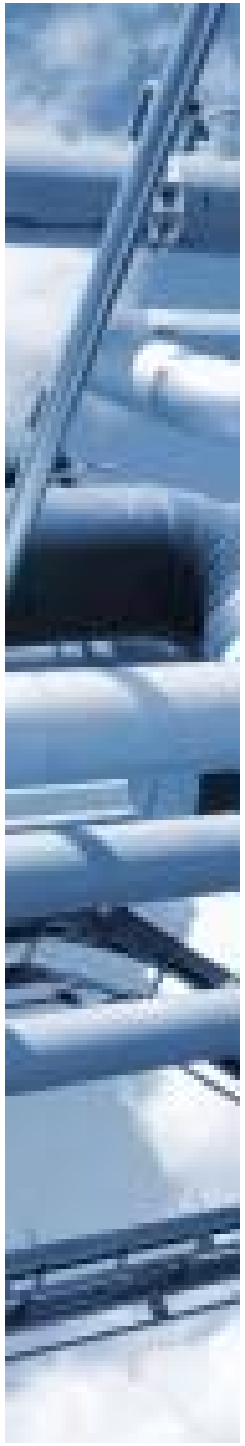
Instrument Identification and Tag Numbers



Function Identification
(Instrument Type)

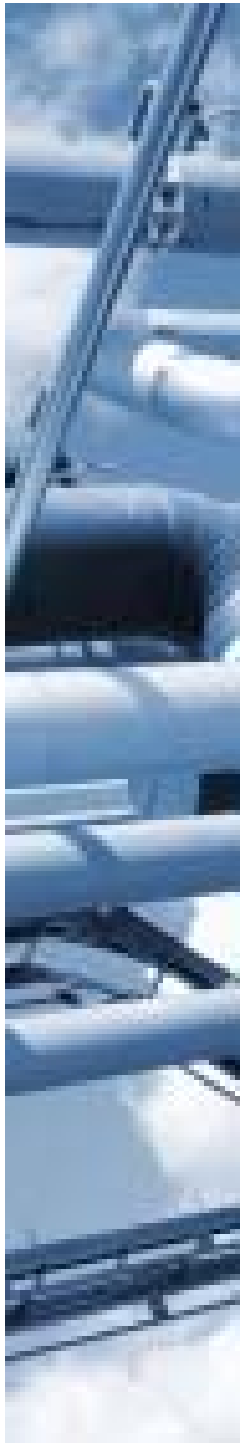
Sequence (Tag) Number

- Each instrument type should have a unique sequence number.
- Similar convention applies to valving and equipment, all must have unique identification.



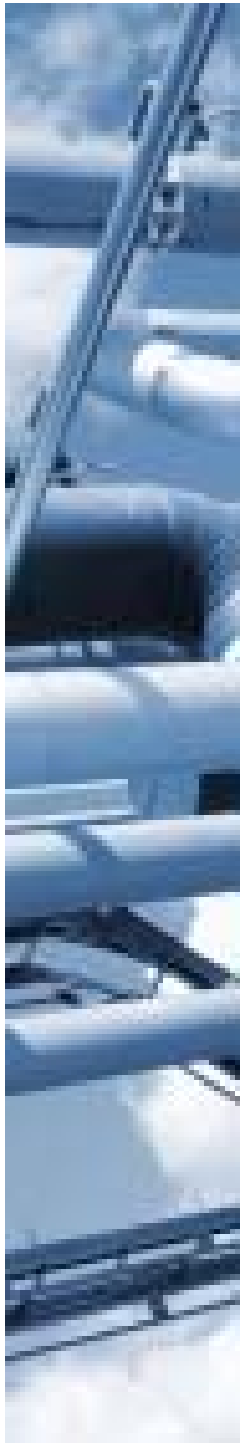
Instrument Nomenclature

Process Measurement	Element Type	Element	Transmitter	Indicator	Indicator controller	Controller	Control Valve	Recorder
	Code	E	T	I	IC	C	V	R
Analysis	A	AE	AT	AI	AIC	AC	ACV	AR
Flow	F	FE	FT	FI	FIC	FC	FCV	FR
Level	L	LE	LT	LI	LIC	LC	LCV	LR
Pressure	P	PE	PT	PI	PIC	PC	PCV	PR
Delta Pressure	dP	dPE	dPT	dPI	dPIC	dPC	dPCV	dPR
Quantity	Q	QE	QT	OI	OIC	QC	QCV	QR
Temperature	T	TE	TT	TI	TIC	TC	TCV	TR
Delta Temperature	dT	dTE	dTT	dTI	dTIC	dTC	dTCV	dTR
Vibration	Y	YE	YT	YI	YIC	YC	YCV	YR
Position	Z	ZE	ZT	ZI	ZIC	ZC	ZCV	ZR

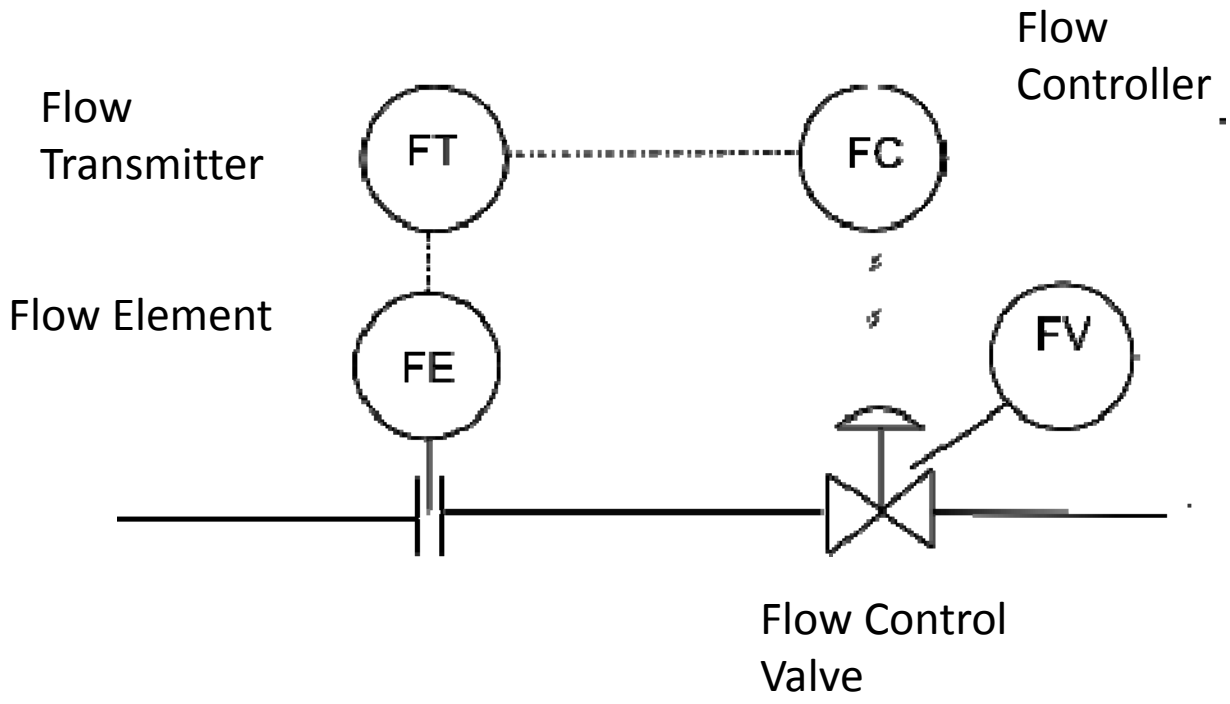


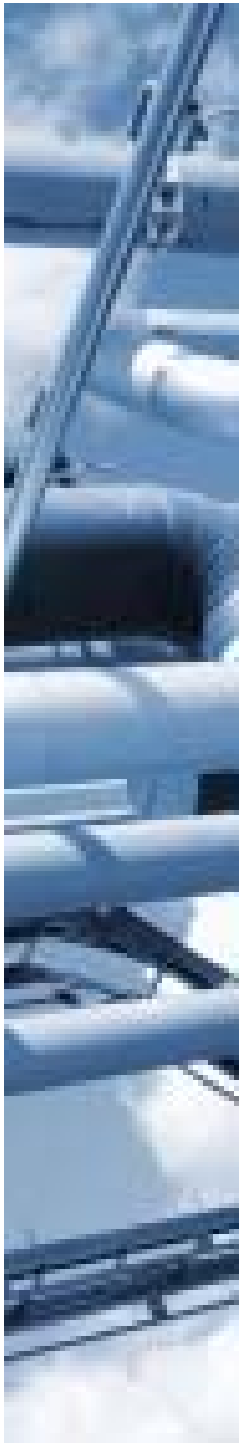
Instrument Nomenclature

Process Measurement	Element Type	Ratio Calculation	Switch Low	Switch High	Alarm Low	Alarm Low Low	Alarm High	Alarm High High
	Code	FY	SL	SH	AL	ALL	AH	AHH
Analysis	A	AFY	ASL	ASH	AAL	AALL	AAH	AAHH
Flow	F	FFY	FSL	FSH	FAL	FALL	FAH	FAHH
Level	L	LFY	LSL	LSH	LAL	LALL	LAH	LAHH
Humidity	M	MFY	MSL	MSH	MAL	MALL	MAH	MAHH
Power	N	NFY	NSL	NSH	NAL	NALL	NAH	NAHH
Pressure	P	PFY	PSL	PSH	PAL	PALL	PAH	PAHH
Delta Pressure	dP	dPFY	dPSL	dPSH	dPAL	dPALL	dPAH	dPAHH
Quantity	Q	QFY	QSL	QSH	QAL	QALL	QAH	QAHH
Temperature	T	TFY	TSL	TSH	TAL	TALL	TAH	TAHH
Delta Temperature	dT	dTFY	dTSL	dTSH	dTAL	dTALL	dTAH	dTAHH
Vibration	Y	YFY	YSL	YSH	YAL	YALL	YAH	YAHH
Position	Z	ZFY	ZSL	ZSH	ZAL	ZALL	ZAH	ZAHH

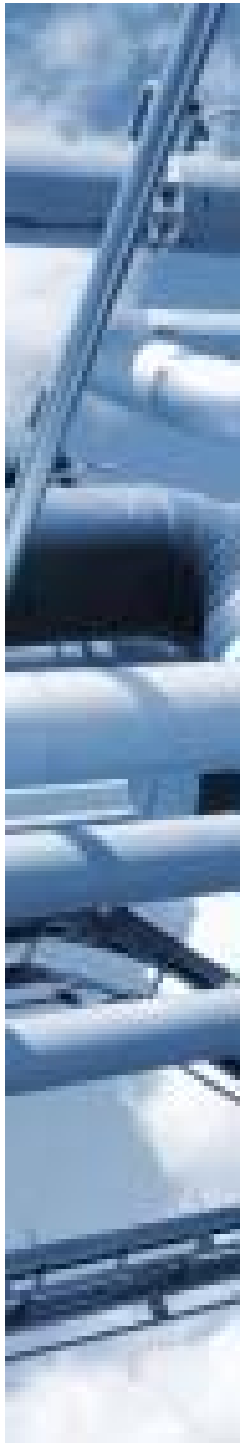


Instrument Loop Example



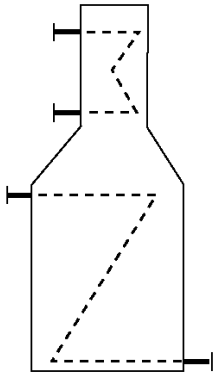


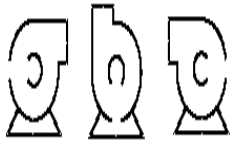
Equipment

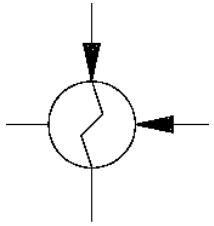


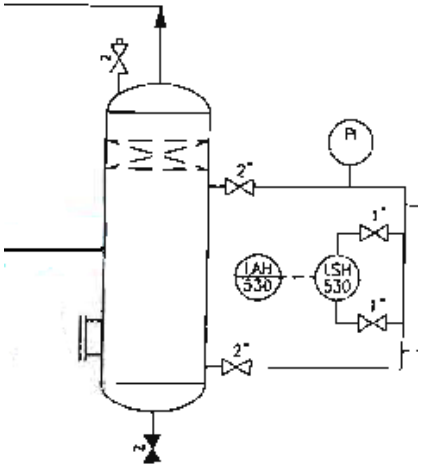
Equipment

- Key process equipment:
  - Accumulator
  - Separator
  - Reactor
  - Fractionating Columns
  - Heat Exchanger
  - Air-Fin Coolers
  - Heater
  - Compressor
  - Pump

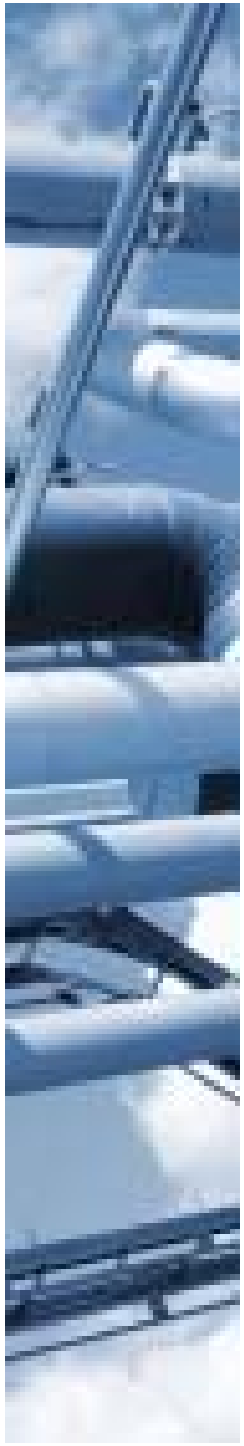








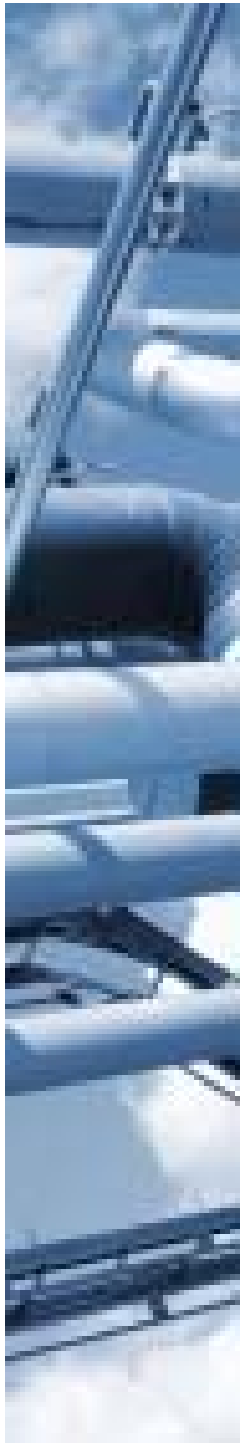
- Names and types vary based on the industry they're used.



Importance of Quality P&ID's During a HAZOP Study

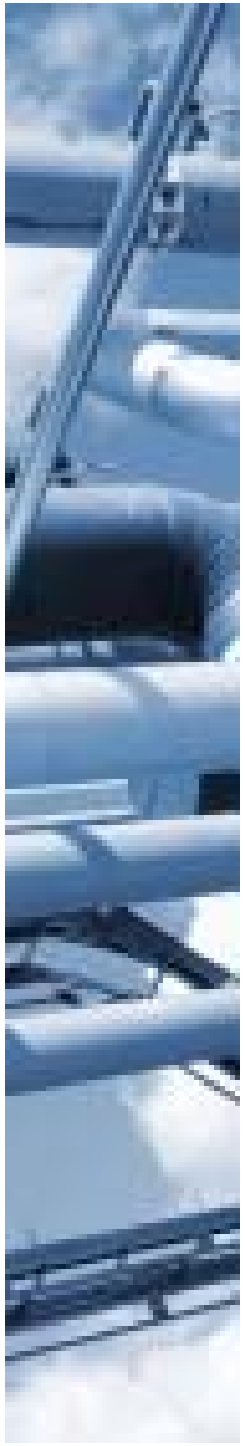
High Quality P&ID's

- Accurate and Detailed P&IDs allow for high quality and efficient HAZOP sessions
  - Enables the Team to better define and evaluate scenarios
  - Results in valuable Recommendations vs "verify" Recommendations
- Key Information on P&IDs enable the Team to identify areas of concern that may otherwise be overlooked during the HAZOP
- Common link between the HAZOP and process documentation/procedures (e.g. PSI, SOP, MI)
- Prevent LARGE headaches during 5yr revalidations or MOC HAZOP Studies.



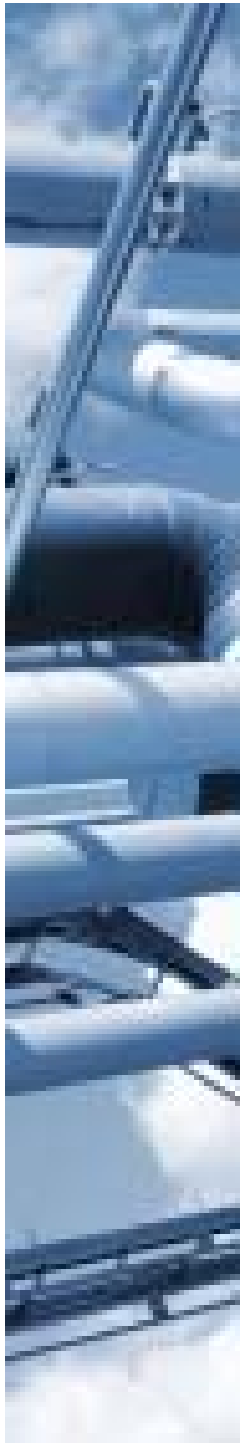
Key P&ID Information

- Piping information:
  - pipe size
  - materials of construction, design conditions
  - spec breaks
  - heat tracing
  - insulation
- Enables the Team to determine the adequacy of pipe for service and special considerations
  - Corrosion
  - Runaway Reactions
  - Changing process flow



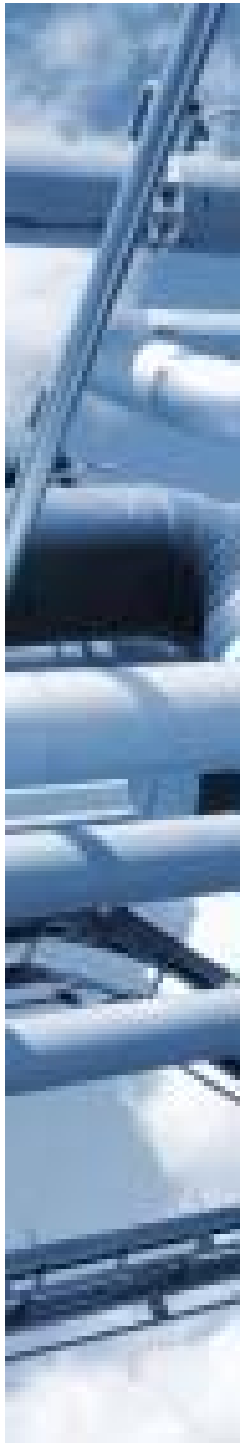
Key P&ID Information

- Equipment information:
  - type
  - size
  - material of construction
  - Pipe and equipment design conditions (temperature and pressure)



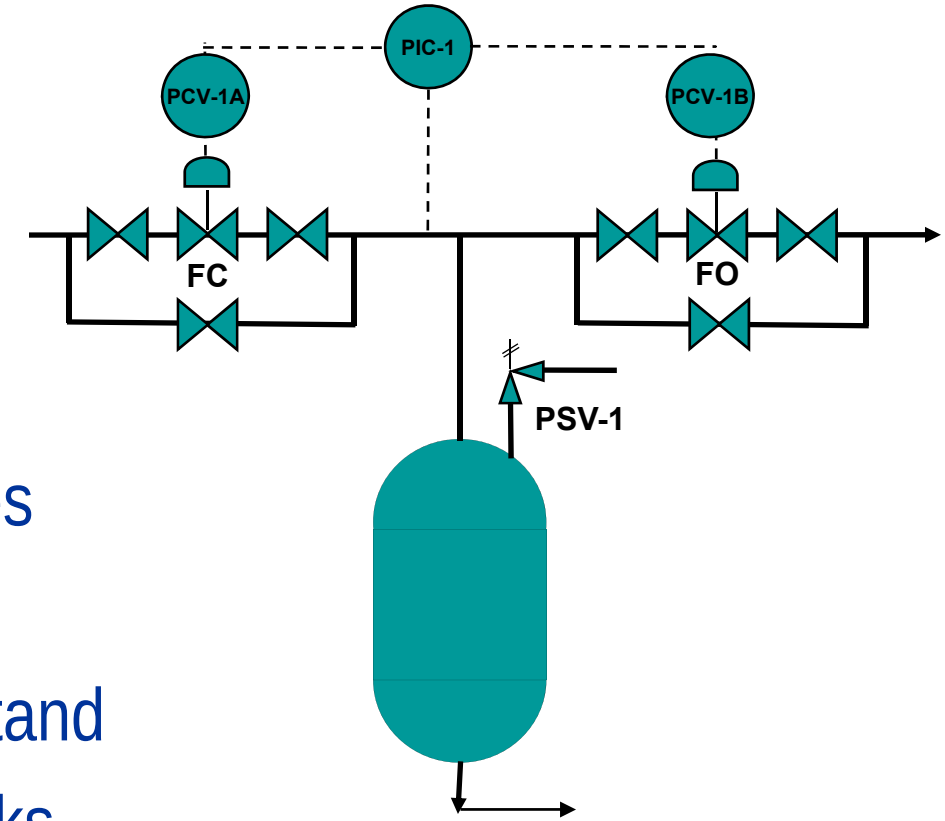
Key P&ID Information

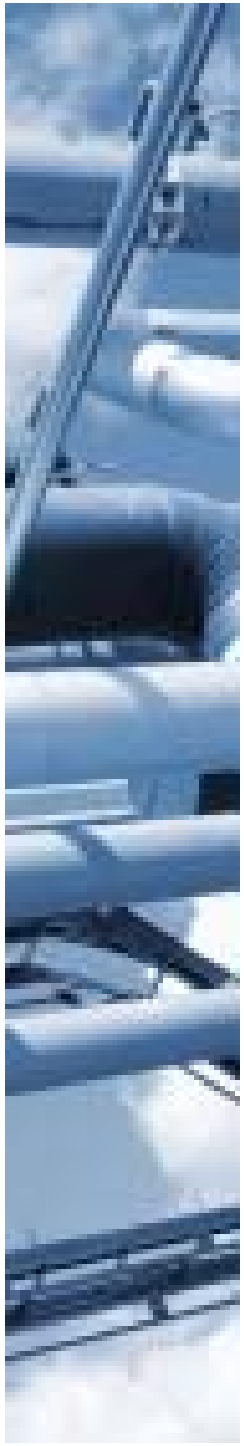
- Instrumentation and Controls information:
  - Instruments
    - Monitoring (local or control room)
    - Controlling (valve local, instrument in control room)
    - Emergency(Local or Control Room)
      - Alerting
      - Automatic Action



Key P&ID Information

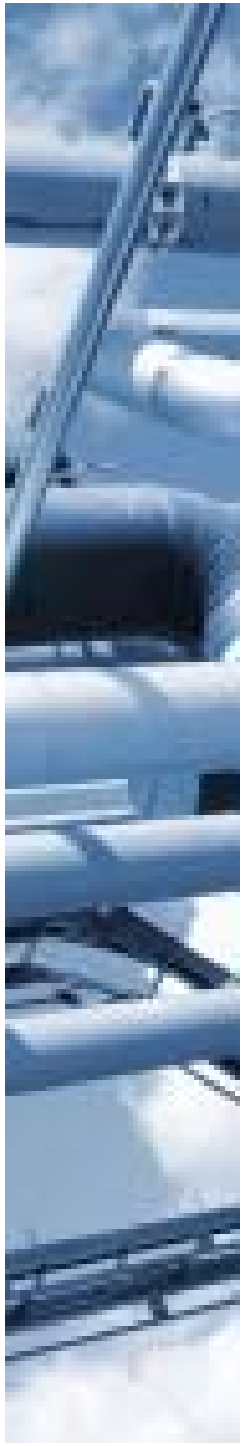
- Complete Instrumentation and Controls information:
  - Helps define the process
  - Enables the Team to verify the failure modes
  - Enables the Team to understand controls/interlocks



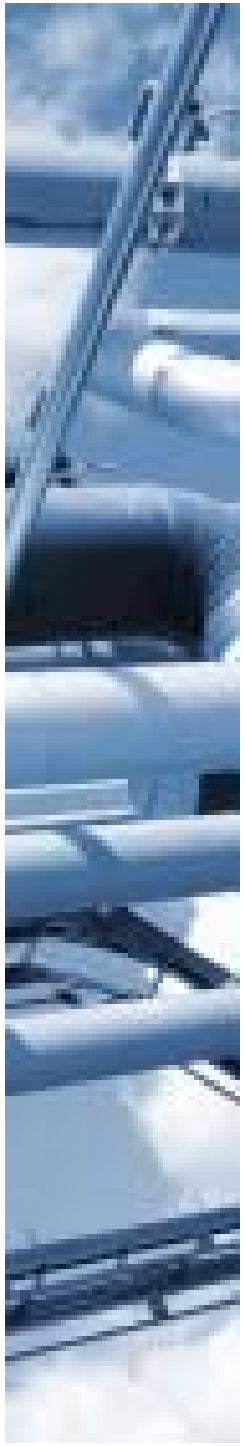


Key P&ID Information

- Safety Systems information:
  - Safety Systems
    - Relief Valves
    - Flare Systems
    - Emergency Trips and Actions
  - Information on the settings and actions of safety systems should be identified

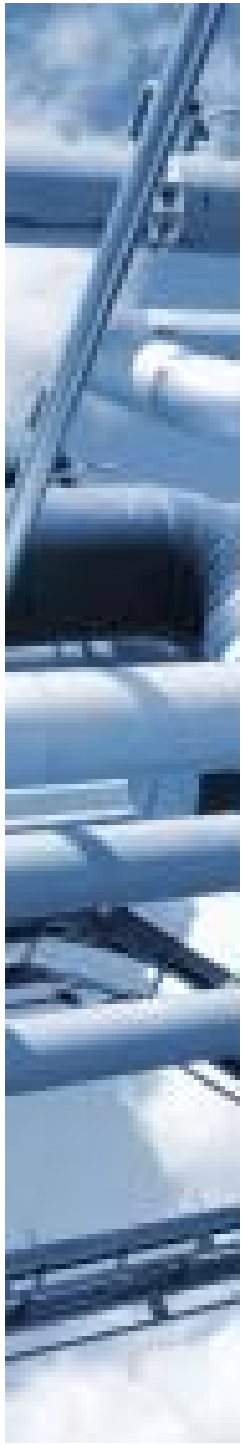


Signs that a P&ID has not been Field-Verified



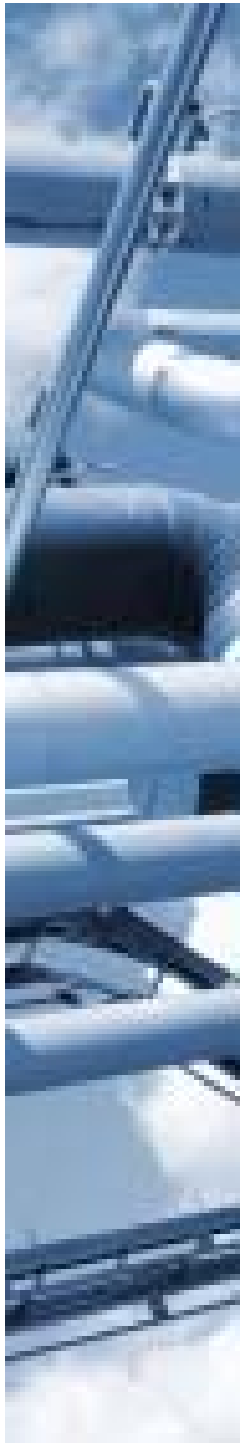
Inaccurate P&IDs = Invalid HAZOP Study

- Indications that a Field Verification is necessary
  - Revision block and dates on P&ID not current (although changes have been made)
  - Outdated equipment information
  - Flow streams do not make sense



Prior to HAZOP

- Investigative work prior to scheduling the HAZOP
  - Review MOC's
  - Interview Operations and Maintenance personnel to identify process changes
  - Update controls summary and C&E's as necessary
  - Field verify any changes and "spot-check" a section that has not been changed for accuracy



Questions?

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Risk Management Professionals